SCIENCE ABSTRACTS.

SECTION A.—PHYSICS.

VOL. XXI

1918

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ERRATA.

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Abstract No. 21, line 9 : *for* Serres, *read* Seares.
Abstract No. 70, line 3 : *for* Sherrer, *read* Scherrer.
Abstract No. 76, p. 22, line 2 from bottom : *for* 0—80°, *read* 0 to 80°.
Abstract No. 87, line 4 from end : *for* terminal, *read* terminated.
Abstract No. 100, line 5 from end : *for* data Tl, *read* data for Tl.
Abstract No. 167, p. 65, line 5 from end : *for* $h\nu_A$, *read* $h\nu_A$.
Abstract No. 217, line 7 : *for* Reeknagel, *read* Recknagel.
Abstract No. 316, line 2 : *for* Driessen, *read* Driesen.
Abstract No. 357, line 10 : *for* Lorenz, *read* Lorentz.
Abstract No. 382, line 3 : *for* Sherrer, *read* Scherrer.
Abstract No. 430, p. 199 : should *read* 480.
Abstract No. 440, line 17 : *for* atmo., *read* 1 atmo.
Abstract No. 592, line 3 : *for* Bregmesser, *read* Breymesser.
Abstract No. 707, line 2 : *for* Rheinhold, *read* Reinhold.
Abstract No. 834, line 2 : *for* Mervin, *read* Merwin.
Abstract No. 879, line 2 : *for* Organisation, *read* Ozonisation.
Abstract No. 912, line 4 from end : *for* ease, *read* case.
Abstract No. 924, line 5 : *for* liquid sazoxyphenetol, *read* liquids azoxyphenetol.
Abstract No. 1062, p. 417, line 3 : *for* Schwartzschild, *read* Schwarzschild.
Abstract No. 1178, last line but one : *for* Larmer, *read* Larmor.
Abstract No. 1182, for missing reference see Abstract No. 1264.

CORRIGENDA.

Abstract No. 89 ; Author's correction in Phys. Zeits. 19. pp. 388, 389, Sept. 1, 1918.
Abstract No. 399 ; Author's correction in Phil. Mag. 36. p. 271, Sept., 1918.
Abstract No. 1245 ; Author's correction in Phys. Rev. 12. p. 493, Dec., 1918.
Abstract No. 1246 ; Author's correction in Phys. Rev. 12. p. 493, Dec., 1918.
Abstract No. 1268 ; Author's correction in Phys. Rev. 12. p. 493, Dec., 1918.

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Astron. Soc. of the Pacific, Publ.	Publications of the Astronomical Society of the Pacific	——	——
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El. Rly. J.	Electric Railway Journal	Single copy, 15 cents; $6.00 per annum, post free	McGraw Hill Publishing Co., Inc., 10th Avenue at 36th Street, New York, U.S.A.
El. World	Electrical World	Single copy, 15 cents; $8.00 per annum, post free	McGraw Hill Publishing Co., Inc., 10th Avenue at 36th Street, New York, U.S.A.
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Nat. Acad. Sci., Proc.	Proceedings of the National Academy of Sciences	Single copy, 50 cents; $5.00 per annum	National Academy of Science, Smithsonian Institute, Washington, D.C.
New Zealand J. of Science	New Zealand Journal of Science and Technology	Single copy, 1s. 6d.; 6s. per annum, post free.	Dominion Museum, Wellington, New Zealand
Optical Soc., Trans.	Transactions of the Optical Society	Price to non-members, 3s., except for supplement	39, Victoria Street, Westminster
Soc. Franç. Élect., Bull.....	Bulletin de la Société Française des Electriciens, formerly Bulletin de la Société Internationale des Electriciens	Single copy, 3 fr.; 32 fr. per annum, post free.	Gauthier-Villars et Cie, 55, Quai des Grands-Augustins, Paris
Terrestrial Magnetism	Terrestrial Magnetism and Atmospheric Electricity	Single copy, 90 cents; $3.25 per annum, post free	John Hopkins Press, Baltimore, Maryland, U.S.A., and William Wesley & Son, 28, Essex Street, Strand, London
Wireless Age	Wireless Age	Single copy, 20 cents;	Wireless Press, Inc., 25, Elm Street, New

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SCIENCE ABSTRACTS

SECTION A.—PHYSICS.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JANUARY 1918.

GENERAL PHYSICS.

1. *New "Total-immersion" Hydrometer.* **A. Ångström** and **H. Pettersson.** (Zeits. Instrumentenk. 37. pp. 177–180, Sept., 1917.)—To a glass bulb, weighted with shot, and of about 25 cm.^{3} external volume, is attached a fine chain about 40 cm. long. The chain is made of doubly-gilded brass and contains about 500 links of equal weight. When the bulb and chain are put into a glass cylinder containing a liquid of such density that the bulb is totally immersed, the bulb will sink in the liquid and the chain will coil up on the bottom of the cylinder until a position of equilibrium is reached. The cylinder containing the liquid is so graduated that the density of the liquid in it can be determined from the position of the pointed upper end of the glass bulb. It is shown that the max. error in the density is less than the accuracy with which the divisions on the cylinder can be read, the average error not exceeding 0·02 %. If the bulb is made of quartz, the chain of gold, and a Dewar vacuum vessel is used to contain the liquid, an accuracy of about 0·002 % can be obtained. It is convenient to have a glass cylinder with a false bottom on which the chain coils up. The bottom of the cylinder is drawn out to a tube and fitted with rubber tubing and clip so that the liquid can be conveniently run out. T. S. P.

2. *Erratic Changes in Clock Rates.* **W. A. Conrad.** (Popular Astron. 25. p. 522, 1917. Nature, 100. p. 272, Dec. 6, 1917. Abstract.)—Sudden changes in the rates of the three standard clocks at the United States Naval Observatory, Washington, appear to have been traced to the action of "cold waves" accompanied by a marked low-pressure area receding to the east and an abnormally high barometer to the west. It is suggested that the observations of the clock-stars may have been affected by lateral refraction. C. P. B.

3. *Determination of Instrumental Systematic Errors.* **K. Lüdemann.** (Vereinig. v. Freunden. d. Astron. u. Kosm. Physik, Mitt. 26. pp. 1–11, 1916. Zeits. Instrumentenk. 37. pp. 155–156, July, 1917. Abstract.)—A short account is given of the determination of errors of a small divided circle. C. P. B.

4. *Limitations of the Balance.* **B. Blount.** (Chem. Soc. J., Trans. 111. pp. 1035–1039, Nov., 1917.)—Weighings on six balances of the best make (Oertling, Bunge and Sartorius) were made by three people at two different places, London and Cambridge, over a period of four months, all necessary precautions being taken. Variations of from 0·4 to 1·6 mgm. were observed and could not be correlated with any variation of external conditions. The effects could not be accounted for by any difference in temperature between the two arms of the beam, nor by the existence of unequal stresses in the arms. In the case of the six balances, two had their end knife-edges set in sealing-wax, two were held by set screws, and the other two were apparently pressed in. In all three methods of construction, fortuitous movement of the knife-edge is easily conceivable, thus bringing about an alteration in the effective length of the two arms of the balance, and it is to this explanation that the author inclines. T. S. P.

5. *Pressure due to Collapse of Bubbles.* **Rayleigh.** (Phil. Mag. 34. pp. 94–98, Aug., 1917.)—The problem of the pressure developed by the collapse of spherical cavities in a liquid has been investigated by Besant; and S. Cook, starting from his result, has determined the pressure developed when the collapse is suddenly arrested by a rigid concentric obstacle, a problem of interest in connection with the cavitation behind screw-propellers. In the present note a simpler derivation of Besant's results is given, and the calculation is extended to find the pressure in the interior of the fluid during collapse. It appears that before the cavity is closed these pressures may rise to very high values in the fluid near the inner boundary. G. W. DE T.

6. *Solar Radiation and Terrestrial Meteorology.* **H. H. Clayton.** (Smithsonian Misc. Coll. 68. No. 3. Nature, 100. p. 14, Sept. 6, 1917. Abstract.)—Comparisons of variations of solar radiation were made with temperature observations at Pilar, in Central Argentina, and with temperature and pressure variations at a number of widely distributed stations. The pressure correlation was found to be inverse to that of temperature. In the tropics the temperature rises and falls, following the solar variations by about 2 days. Analysis of the solar variations suggests a period of about 22 days. C. P. B.

7. *Periodic Convection Currents in the Atmosphere.* **H. Jeffreys.** (Phil. Mag. 34. pp. 449–458, Nov., 1917.)—In a previous paper [Abs. 1233 (1917)] the author investigated the validity of the usual assumption that the velocity can be neglected in forming the equations of vertical motion. Certain restrictions were, however, imposed with a view to rendering the equations soluble. In the present paper all the restrictions are removed, with the exception of the first, which replaced the atmosphere by an incompressible fluid of finite depth. R. C.

8. *Revolving Fluid in the Atmosphere.* **N. Shaw.** (Roy. Soc., Proc. 94. pp. 34–52, Nov. 5, 1917.)—The common assumption that cyclones and anticyclones are areas of revolving fluid is erroneous, as is seen when the actual paths of portions of air which compose them are traced. The motion of air in these forms of isobars is only instantaneously circular—the actual paths are compounded of the instantaneous motion of the air and of the motion of translation of the whole system, and are usually looped in shape in the case of cyclones.

Revolving fluid can, however, occasionally be identified in the southern area of a cyclone where a "secondary" is sometimes shown on the map, and it can be shown that the paths of air for revolving fluid which is moving

bodily forward are a family of conic sections, similar in general appearance to the isobars of secondary depression. It is shown that in certain circumstances it is legitimate to assume that the isobars coincide approximately with the actual paths of air in these cases, and the conclusion is reached that the velocity of translation of the revolving fluid is that due to the distribution of pressure in regions near to, but undisturbed by, the revolving fluid. The conditions for permanence are : (1) that the column of revolving fluid must extend to the stratosphere, (2) that the velocity of the general current carrying the revolving fluid should be uniform at all levels, otherwise the eddy would be torn asunder. These conditions are not easily attained, but in favourable circumstances they can be identified in the southern portion of a cyclone, and in fact it is that region whence two cases of revolving fluid which are given as illustrations are derived. One of these cases is that of a very destructive secondary, the other is that of a tornado which visited Wales and the West of England in 1913. The former is easily identifiable on an ordinary weather map as a secondary, the latter had a diameter of about 300 yards, and was therefore not shown on the weather map. It is probable that the tornadoes of the United States are similarly related to the general distribution of pressure. R. C.

9. *Tidal Energy Dissipation.* **R. O. Street.** (Nature, 100. pp. 145–146, Oct. 25, 1917.)—Agreeing with Jeffreys's view that it is still doubtful whether the viscosity of the ocean causes an appreciable portion of the earth's retardation [Abs. 1099, 1100 (1917)], it is pointed out that the internal energy will be in part energy of currents arising from temperature differences, and therefore supplied by the solar heat and not by the energy of the earth's rotation ; so that the question can only be fully discussed when more is known of the distribution of ocean currents. The author finds it more difficult to agree with Jeffreys in the contention that viscous action in a solid earth cannot be an appreciable cause of the slowing of its rotation. **H. Jeffreys.** (*Ibid.* pp. 186–187, Nov. 8, 1917.)—Jeffreys replies to Street. The discussion is continued on the possible effects produced by stresses of different periodicities in relation to the action of viscosity. C. P. B.

10. *The Isostatic Subsidence of Volcanic Islands.* **W. M. Davis.** (Nat. Acad. Sci., Proc. 3. pp. 649–654, Nov., 1917.)—Objection has sometimes been made to Darwin's theory of upgrowing coral reefs on subsiding foundations, on the ground that the subsidence of the reef foundations should lower the ocean surface and lay bare a belt of recent marine deposits of smooth surface and simple shore line around the continental masses, while as a matter of fact the shore lines of continents are usually more or less embayed, as if the sea had recently advanced upon the unevenly erroded surface of the continental margins. The objection will, however, be found to have small weight when it is seen to rest upon the implied postulate that the embayments of continental coasts have as a rule been produced by a universal rise of the ocean surface, everywhere of the same amount and date, whereas their embayments testify to no such simple origin, and to proceed upon the unwarranted assumption that the subsidence of reef foundations requires the subsidence of broad areas of the ocean floors, whereas the local subsidence of the foundations themselves is all that is necessary. The postulate is first examined and refuted ; the assumption is then considered and its alternative found to be preferable. Darwin's primary theory of coral reefs is therefore found to hold good, although his supplementary theory of broad ocean-floor subsidence needs modification. H. H. Ho.

11. *Recent Progress in Astronomy.* **A. de la Baume Pluvinel.** (Observatory, No. 517. pp. 327–340, Sept., 1917.)—Presidential Address before the Soc. Astron. de France.

12. *Absorption Bands of Atmospheric Ozone in Spectra of Sun and Stars.* **A. Fowler** and **R. J. Strutt.** (Roy. Soc., Proc. 93. pp. 577–586, Oct. 9, 1917.)—In 1890 Huggins announced the discovery of a conspicuous group of six lines in the ultra-violet region of the spectrum of Sirius, extending from λ3199 to λ3338. Examination of a later photograph taken with a quartz prismatic camera at Edinburgh led the present authors to regard the appearance as a system of bands rather than a group of lines. Ladenburg and Lehmann had noted a number of bands in this region as due to the absorption spectrum of ozone, but the wave-lengths given were not quite in agreement. A special investigation now results in the satisfactory determination of the coincidence of these ozone absorption bands with the prominent bands in the spectrum of Sirius and in the solar spectrum when the sun is at very low altitudes. The coincidence is further proved by the detection of the same bands in the spectra of many other stars. For the laboratory records light from a source giving strong continuous radiation, carbon arc or burning magnesium, was passed through freshly prepared ozone contained in tubes varying in length from 8 ft. to 18 in., and also into special silica receptacles for small volumes. The spectra were photographed with a small quartz spectrograph giving a linear dispersion of 58 Å. per min. at λ3200. A list is given of the wave-length of the bands found between λ3089 and λ3432, and it is noted that photographs taken with higher dispersion gave no indications of the resolution of the bands into close component lines. Examples are shown of the spectra of the high and the low sun which leave no doubt that these bands are present in the solar spectrum with greater intensity at low altitudes, and therefore may be regarded as of terrestrial origin. Support is thus given to Hartley's suggestion that atmospheric ozone is the effective agency in fixing the extension of the solar spectrum to the ultra-violet. C. P. B.

13. *Empirical Law connecting the Distances of the Planets from the Sun.* **E. Belot.** (Observatory, No. 520. pp. 457–458, Dec., 1917.)—Belot does not agree with the procedure of Armellini [Abs. 1348 (1917)] in computing mean errors in connection with the exponential law of planetary distances demonstrated by Belot in 1905, and afterwards extended to the distances of the satellites in 1911. Also he does not agree to discard an empirical law because it gives "vacant places." These may well be filled up by future discoveries. C. P. B.

14. *Orbit of Comet* 1914*c*. (*Neujonin*). **J. Svardson.** (Stockholm Observat., Astron. Iaktt. 10. No. 6. Nature, 100. p. 154, Oct. 25, 1917. Abstract.)—The comet was never very bright, but was observed during the 182 days from June 27 to Dec. 22. Corrections are introduced for perturbations due to Jupiter, and a set of hyperbolic elements given. Considerable resemblance is shown to the orbit of the comet of 1729. C. P. B.

15. *Brester's Theory of the Sun.* **A. Brester.** (Nature, 100. pp. 154–155, Oct. 25, 1917.)—The author has issued a pamphlet giving the general conclusions of his solar theory, suggesting that the sun has a relatively tranquil surface, with gases decreasing in density and luminosity from the centre outward. Sun-spot activity is attributed to actions of temperature changes

while the chromosphere, prominences, and corona are regarded as effects of a permanent aurora, maintained by electrons projected from the photosphere. C. P. B.

16. *Curvature of Space.* **W. de Sitter.** (K. Akad. Amsterdam, Proc. 20. 2. pp. 229–243, 1917.)—Developments are outlined of Einstein's equations along two systems, one involving an inertia field only, the second including the action of a gravitational field, taking into consideration the results obtained by numerous other investigators on this question. Some of the results appear to be related to the observed peculiarities of abnormal radial velocities, and further spectroscopic results may lead to some definite conclusion as to the presence of "world matter" and "ordinary matter" is cosmical space [see Abs. 1077 (1917)]. C. P. B.

17. *Algebraic Derivation of Cowell's Gravitational Formula.* **N. Liapin.** (Observatory, No. 517. pp. 343–345, Sept., 1917.)—A method is shown by which Cowell's formula for correcting the motions of celestial objects may be simply derived by utilizing symmetry of algebraical expressions. **A. S. Eddington.** (Ibid. No. 518. pp. 374–375, Oct., 1917.)—Eddington gives another method for the derivation of Cowell's result. C. P. B.

18. *Fall of Meteorite in Perthshire.* (Nature, 100. p. 291, Dec. 13, 1917.)—On 1917, Dec. 3, about 1.15 a loud noise was heard near Blairgowrie Strathmore, and Coupar Angus, and a house was struck at the latter place. Three pieces of the meteorite appear to have been found, weighing 22½, 2¼ and 2¼ lbs. respectively, which were distributed over a distance of 6 miles in a S.E. to N.W. direction. The radiant point is computed to be 302°, + 24.° C. P. B.

19. *Physical History of Lunar Volcanoes.* **E. Belot.** (Comptes Rendus, 165. pp. 177–180, July 30, 1917.)—The author traces the development of the volcanic production of the lunar craters, showing that if the explosive force is ascribed to expanding water-vapour, the great depth corresponding to the critical pressure of water (5·8 km.) would explain to a large extent the enormous extent of many of the crater rings. Modifications of the activity are described in explanation of special features, such as double walls, as in Petavius, specially deep craters, as that of Theophilus (5500 m.), and the central secondary craters so frequently present. [See Abs. 863 (1916).] C. P. B.

20. *Determination of Galactic Condensation.* **F. H. Seares.** (Astrophys. J. 46. pp. 117–137, Sept., 1917.)—Detailed analysis of the collection by H. H. Turner of counts of nearly 600,000 stars on the photographs for 10 zones of the Astrographic Catalogue, extending from declination + 62° to — 65°, has been made with the idea of determining the law of stellar distributions with regard to the Milky Way. The value of galactic condensations found is in practical agreement with that derived by Kapteyn, which becomes greater as increasingly fainter stars are considered. The deviations of the observed densities from the mean distribution show systematic variations in right ascension which, although definite, are not larger than the uncertainties affecting the results; and, moreover, they are not in agreement with the spiral of obscuration determined by Turner. The discordance is ascribed to Turner neglecting any allowance for the high galactic condensation for the faint stars. [Abs. 756 (1917).] C. P. B.

21. *Spiral of Obscuration in Stellar Universe.* **H. H. Turner.** (Astrophys. J. 46. pp. 226–231, Oct., 1917.)—In reply to the criticism of Seares [see preceding Abs.] Turner rearranges part of the material discussed and shows that it does afford evidence of the spiral of obscuration. Also the questions of seasonal variation of the observations, and the accordance of different zones have previously been taken into account. No definitive conclusion can be obtained until the whole of the available information is discussed. **F. H. Seares.** (Mt. Wilson Solar Obs. Contrib. No. 139. Astrophys. J. 46. pp. 232–237, Oct., 1917. In further reply to Turner Serres emphasizes the effects of the different zones showing in themselves differences in the value for the galactic condensation, and adheres to his first contention, that the spiral of obscuration, for the most part, is only the increasing galactic condensation which appears with increasing limiting magnitude exhibited under another form, and that the spiral disappears when the data are freed from the affects of the condensation. C. P. B.

22. *Density of Stars in Reference to their Galactic Coordinates.* **F. W. Dyson** and **W. G. Thackeray.** (Roy. Astron. Soc., M.N. 77. pp. 648–650, Oct., 1917.)—In a former paper a comparison was made of the relative densities of stars of different proper motions in different galactic latitudes from an investigation of the stars in zone 24°–32° N. decl. [see Abs. 1247 (1917)]. In order to study the comparison of bright stars with much fainter stars, and also on account of the smaller errors involved, a similar discussion has been made of the stars in Boss's Preliminary General Catalogue. The results are in accordance with the previous values in that they show that stars of sensible proper motion exhibit a continual increase as the Milky Way is approached. This tendency is greatest for stars of very small proper motion, but is well marked in the stars of proper motions smaller than 6″ a century. C. P. B.

23. *Possible Drift Companion to α Centauri.* **J. Voûte.** (Roy. Astron. Soc., M.N. 77. pp. 650–651, Oct., 1917.)—Parallax observations have been made of the faint star (magnitude 13) recently found by Innes in the constellation Centaurus, and having about 5″ proper motion. The difference in visual and photographic magnitude is at least 2·5, so that the star must be reddish, and it is suggested that its spectral type may be Mb. The parallax is $\pi = +0{\cdot}755''$, that of α Centauri being $\pi = +0{\cdot}759''$. Seeing that the proper motion and parallax of this star and α Centauri are so closely in agreement, it becomes of interest to determine whether they may be physically connected, or are members of the same star drift. C. P. B.

24. *Errors affecting Visual Estimations of Brightness and Colour.* **H. Osthoff.** (Astron. Nachr. Nos. 4897–4898. Observatory, No. 520. pp. 451–455, Dec., 1917. Abstract.)—In connection with the observation of variable stars without photometric apparatus many errors, chiefly physiological, are liable to be found in the estimates of brightness and colour. These are summarised as (1) Purkinje phenomenon; (2) position of retina with respect to incident light, the sensation varying according to whether the rods or cones are stimulated; (3) depth of colour varies with intensity; (4) difficulty of estimating relative brightness of two objects noticeably different in colour; (5) increase of brightness of an object with continued action on retina; (6) contrast effects; (7) dilatation of pupil of eye changing during observing period; (8) influence of moonlight, etc., on magnitude and colour estimates; 9) errors depending on position or orientation of stars in field of view.

 C. P. B.

25. *Nova Ritchey.* (Observatory, No. 520. pp. 455–456, Dec., 1917.)—A new star was announced in July 1917 to have been discovered by Ritchey in the outer portions of the spiral nebula N.G.C. 6946, its magnitude being about 14. On earlier plates no star as bright as the twentieth magnitude was visible. A photograph of the nebula showing the Nova was obtained by Wolf at Königstuhl on Aug. 21, and is reproduced with this note. A subsequent communication from Harvard stated that the Nova rapidly became fainter, and that its colour-index indicates that it cannot be a long-period variable. A spectrogram has been obtained by Ritchey, and Pease with the Mt. Wilson 60-in. reflector and a slitless spectrograph, giving an exposure of 6 hours. There was a strong continuous spectrum, crossed by what appears to be a number of bright bands. C. P. B.

26. *Parallax and Proper Motion of Ring Nebula in Lyra.* **B. L. Newkirk.** (Lick Observat. Bull. 9. [No. 299.] pp. 100–107, 1917.)—The investigation is based on a study of 88 plates of the Ring Nebula in Lyra made with the Crossley Reflector at Mt. Hamilton from 1906 to 1916. Nine comparison stars were used, eight of which are of about the same magnitude as the comparison star. Evidence is found for systematic error, the possible causes of which are dealt with in some detail. It is concluded that the parallax of the central star is less than two hundredths of a second of arc, and the proper motion less than one second per arc per century. C. P. B.

27. *Three Novæ in Spiral Nebulæ.* **H. D. Curtis.** (Lick Observat. Bull. 9. [No. 300.] pp. 108–110, 1917.)—Comparison of plates taken of the nebula N.G.C. 4527 at different stations from 1900 to 1915, resulted in the conclusion that a small star of 8″ north and 44″ following the nucleus must be regarded as a Nova having evidently appeared shortly before 1915 March 20. No trace of it is visible on the plates of 1901 or 1917. A second Nova appeared in the spiral nebula N.G.C. 4321 some time previous to 1901 March 17, and a third Nova in the same nebula some time prior to 1914 March 2. Reproductions are given from photographs of the nebulæ showing the appearance with and without the Novæ. In all six Novæ are now known to be associated with spiral nebulæ. C. P. B.

28. *Physical Study of Planetary Nebulæ.* **W. K. Grant.** (Lick Observat. Bull. 9. [No. 298.] pp. 92–99, 1917.)—Special photographs of the planetary nebulæ N.G.C. 6543 and N.G.C. 7009 have been taken with the Crossley reflector, using Seed 30 plates and a colour screen transmitting radiation from λ4850 to λ5050, and the images measured with a microphotometer to determine the intensity at various points in the image. Spectrograms of the nebulæ were also taken with the Mills spectrograph, somewhat modified by having the prisms set for λ4950, and being provided with a new camera lens of 32 in. focal length, giving a spectrum with dispersion of 12 Å. to 1 mm. at the centre of plate, λ4970. These plates give on measurement the radial velocities of numerous points on the nebulæ, the number of points being varied by different orientations of the spectroscope slit. Both nebulæ are apparently gaseous, showing a spectrum almost wholly of bright lines, with some continuous spectrum from the nucleus. A study of the intensity curves from both λ4959 and λ5007, the principal nebular lines, suggests that the objects consist of ellipsoidal shells of gaseous material in rotation. The rotation is not simple, as the regions near the ausa have different velocities from other parts near, and it is suggested that this may be the effect due to subsidiary bands or shells rotating about various axes. C. P. B.

29. *Real Velocities of Meteors.* **C. P. Olivier.** (Observatory, No. 518. pp. 365–368, Oct., 1917.)—From a list of real flights of meteors observed by members of the British Astronomical Association [B.A.A. Journal, Jan., 1917], eight doubly-observed meteors are selected as assigned to a radiant near R.A. = 302°, Decl. — 8°. This position is not far from the ecliptic, and appears to be a very likely example of a stationary radiant. To investigate the orbits reductions were made by Bauschinger's method, and the results are presented in a table showing the elements for each meteor orbit. Some difficulty is introduced by the importance of the durations of the time of flight, the observations of which is scarcely accurate enough when made visually, and it is hoped that systematic work may soon be done with photographic registration, apparatus having been designed for this purpose by the late Cleveland Abbe. It is concluded that the radiant under discussion is the most promising of all those hitherto examined with regard to its likelihood of being a stationary radiant. C. P. B.

30. *Stars with Small Proper Motions and Large Radial Velocities.* **C. D. Perrine.** (Astron. J. 30. pp. 205–207, Sept. 29, 1917.)—A list is given of 71 stars with small proper-motions and large radial velocities for which it is desirable to determine parallaxes. Recent work has shown that if a small proportion of such stars be rejected from discussion, there was strong evidence that the preference for motion in the direction of the ellipsoidal axis was in general confined to the nearer stars. It was also indicated that when the sizes of the proper motions were taken into account there was neither spectral class nor magnitude progression in the radial velocities. It becomes, therefore, of importance to know whether such stars are distant, as their small proper motions indicate, or whether they are relatively near. The stars are selected from the catalogues from Lick and Mount Wilson Observatories. C. P. B.

31. *Photographic Star Positions by Nomonic Rulings.* **R. Innes.** (Union Obs. S. Africa, Circ. No. 39. pp. 313–319, July 10, 1917.)—Maps are being issued from the Union Observatory ruled with nomonic lines showing right ascension and declination instead of the *réseau* lines hitherto used for photographic charting purposes. An example is given with the paper, with a description of the method employed in determining star places from such maps, showing that sufficient accuracy is possible. C. P. B.

32. *Proper Motions with Blink Microscope.* **R. Innes.** (Union Obs. S. Africa, Circ. No. 39. pp. 319–328, July 10, 1917.)—Further tables of proper motions determined by the *Blink* method are given in continuation of those in Circ. 37 [Abs. 902 (1917)]. Many of the displacements are conspicuously towards the solar autopax. C. P. B.

33. *Photographic Magnitudes of Variable Star B.D. + 56·547°.* **C. Martin** and **H. C. Plummer.** (Roy. Astron. Soc., M.N. 77. pp. 651–655, Oct., 1917.)—Attention having been drawn by J. Van der Bilt to the variability of this star, a series of determinations of its varying magnitudes have been made on photographs taken at Dunsink. At first sight the variations appeared irregular, but was found to be well represented by a period of something over 700 days. Three other stars found to be variable in the same region of χ Persei are, however, quite irregular. All the four stars are apparently very red, so it may be that this star is an interesting link between the regular and irregular type of variables. C. P. B.

34. *Structure of Spiral Nebula M 51, Canum Venaticorum.* **L. Becker.** (Roy. Astron. Soc., M.N. 77. pp. 655–662, Oct., 1917.)—Measurement in polar coordinates have been made on one of the published prints of the Spiral Nebula M 51, for determination of the exact form of the component streamers. It was found that the two spirals resemble each other, and corresponding points stand diametrically opposite to each other and equally far from a certain point near the middle of the condensation. The results also suggest that the formula deduced for the curves not only gives the positions of the particles at the present time, but also for any epoch. This leads to the view that any particle is accelerated by a constant central force, such as might be produced by a spheroid whose equator coincides with the equator of the nebula, and in which each particle acts according to the inverse square law. An analysis of this hypothesis is given, with suggested arrangements of the possible physical groupings of the nebula. C. P. B.

35. *Concentration of Stars toward the Galaxy.* **F. H. Seares.** (Nat. Acad. Sci., Proc. 3. pp. 558–562, Sept. 15, 1917.)—Attention has previously been called to the differences found by different observers for the distribution coefficient of stars with respect to the galactic plane [Abs. 608 (1917)]. Further confirmation of the large value of the galactic condensation for faint stars is provided by the Groningen counts of 54 selected areas taken at the Harvard station at Arequipa, and also by the results obtained by H. H. Turner from counts for nearly 600,000 stars of the Astrographic Catalogue. Tables are now given showing the comparison of determinations from Mt. Wilson photographs with those from elsewhere, leading to the conclusion that they satisfactorily confirm Kapteyn's earlier results.

C. P. B.

36. *Monastic and Dualistic Conceptions of Stellar Universe.* **C. V. L. Charlier.** (Scientia, Aug., 1917. Observatory, No. 519. pp. 387–394, Nov., 1917.)—A short account is given of the various theories formulated during the past ten years in the endeavour to furnish a satisfactory explanation of the structure of the stellar universe. On one system the universe is regarded as single and on the way to equilibrium if not actually already in that state. According to the other theory the stellar universe is regarded as due to two intermingling systems, giving rise to a cosmogony which is far from being in a stable state equilibrium. The latter theory has been specially examined in the view of its relation to the kinetic theory of gases, and the various objections which have been made to this are briefly reviewed. **J. H. Jeans.** (*Ibid.* pp. 406–407, Nov., 1917.)—In reply to Charlier, Jeans admits that interpretation of observational material needs modification so as to include the results of recent investigation. The evidence now available indicates that the stellar velocity-ellipsoids show an approximation to prolate spheroids having axes which lie in the galactic plane and are perpendicular to the ratios from the centre of the Galaxy. In the author's opinion the view most nearly agreeing with ascertained facts assumes that the normal star-cluster begins life as a rotating nebula, which, with increasing rotation, takes a spiral form, the condensations in the arms ultimately forming streams of stars. [See Abs. 314, 1115 (1916).] C. P. B.

37. *Positions of Pole Stars and Constant of Aberration.* **L. Becker.** (Roy. Astron. Soc., Mem. 62. pt. 2. pp. 49–78, 1917.)—Observations were commenced in 1897 at the Glasgow Observatory with the re-mounted 6-in. transit circle, a special method being adopted whereby two tenth magnitude stars

were found so close to the pole that their daily orbits lay within the field of the instrument. Formulæ of reduction are included, and tables of results for α and λ Ursæ Minoris. A new determination is given of the constant of aberration, 20·454." C. P. B.

38. *Colour Scale for Stars.* **W. H. Pickering.** (Popular Astron. 25. p. 419, 1917. Nature, 100. p. 93, Oct. 4, 1917. Abstract.)—A series of coloured patches are arranged to be viewed at the same time as a star or planet, means being provided to give this chart a suitable illumination so that standard stars of type K have a constant registration number. C. P. B.

39. *New Star in Spiral Nebula N.G.C.* 6946. **M. Wolf.** (Astron. Nachr. No. 4902. Nature, 100. p. 115, Oct. 11, 1917. Abstract.)—An illustrated account is given of the new star discovered by Ritchey in the spiral nebula N.G.C. 6946, close to the central star. The magnitude on Aug. 21 was 13·5. The star was too feeble to permit of photographic observations of the spectrum. C. P. B.

40. *Maxima of Mira Ceti.* **Nijland.** (Astron. Nachr. No. 4892. Nature, 99. 512, Aug. 23, 1917.)—A summary is given of 79 observations of Mira (o Ceti), obtained at Utrecht between 1916 July 20 and 1917 Feb. 15. Minimum probably occurred on 1916 July 24, when magnitude was 9·4, and maximum on 1916 Nov. 8, with magnitude 3·75. The last three periods have varied from 328 to 324 days. C. P. B.

41. *Relation of Stellar Preferential Motion and Spectral Class to Proper Motion.* **C. D. Perrine.** (Nat. Acad. Sci., Proc. 3. pp. 491–494, Aug., 1917.)—Based on the values of ten radial velocities of some 1800 stars published by Campbell and Adams, the investigation shows that the preference for motion in the direction of the ellipsoidal axis appears to be confined to stars of large proper motion and brighter than 3·0 magnitude in all spectral classes with the possible exception of K and M. The increase in prolateness in stars of large proper motion is traced chiefly to the direction of the ellipsoidal axis, and furnishes a satisfactory explanation of the peculiar behaviour of stars of Class B. The radial velocities of nearer stars are larger than those of more distant stars, and when classified according to size of proper motions there is no certain increase of radial velocity of different spectral classes. When radial velocities are classified according to proper motion, there is no certain change with magnitude. C. P. B.

42. *Orbits of Three Spectroscopic Binaries.* **W. E. Harper.** (Roy. Astron. Soc. Canada, J. 11. pp. 341–345, Oct., 1917.)—Details of determined orbits and radial velocity curves are given for three spectroscopic binaries observed at the Ottawa Observatory; 20 π Cassiopeiæ, mag. 5·2, type A 5, period 1·96408 days; 29 Canis Majoris, mag. 4·77, type Oe, period 4·3934 days; Boss 3511 (D.C. 6501), mag. 5·3, type F, period 1·61275 days. C. P. B.

43. *Collimation of Olcott Meridian Circle.* **A. J. Roy.** (Astron. J. 30. pp. 209–213, Oct. 4, 1917.)—As the result of a long series of determinations it is found that the observations for collimation can be harmonised by the application of a term varying with the temperature—the value for 1897 was $-0·0040$ sec. for 1 deg. C. Tables are given showing the results of a more thorough examination after the instrument had been dismounted and replaced. C. P. B.

LIGHT.

44. *New Form of Spectro-comparator.* **R. E. De Lury.** (Astrophys. J. 46. pp. 219–225, Oct., 1917.)—Two new arrangements for a spectro-comparator are described, the improvement consisting in the employment of a half-silvered surface and two microscopes. In combination with the method devised by Evershed of measuring a negative in conjunction with a positive from it, very consistent results are shown by several sets of trial measures. The main advantages are (1) minimum of optical surfaces are used ; (2) images may be brought into coincidence ; (3) two sets of images are produced, and may be employed as a double comparator ; (4) the instrument may be used either in the ordinary way by bisecting a spider thread, or as a comparator for overlapping or aligning, for which masks for various configurations may be readily interchanged. C. P. B.

45. *Sensitive Tint for Investigating Feeble Double Refraction.* **A. Wenzel.** (Phys. Zeits. 18. pp. 472–479, Oct. 15, 1917.)—In this paper the author discusses the best tints for use in Koenigsberger's method of investigating optical anisotropy. It is shown that if a gypsum plate is used the most sensitive tint is red, the plate thickness giving the best results being about 56 μ. For quartz cut parallel to the optic axis the best colour is that between the Fraunhofer lines E and D, while for quartz cut perpendicular to the axis the most sensitive is blue-violet. A. W.

46. *Production of Coloured Flames of High Luminosity for Demonstration and Experimental Purposes.* **G. A. Hemsalech.** (Phil. Mag. 34. pp. 243–245, Oct., 1917.)—The observation elsewhere recorded [Abs. 1275 (1917)], namely, that the admixture of oxygen to the gases feeding an air-coal gas flame greatly intensifies the flame lines, provides a ready and convenient means of obtaining very luminous coloured flames with either electric or Gouy sprayer. A suitable apparatus embodying this principle and constructed for the purpose of a lecture-experiment is described. It is so arranged as to permit the sprays from six different salt solutions to be passed alternately into the flame without disturbing the stability of the latter. The sprayers are modifications of those described in Abs. 222 (1917).

L. H. W.

47. *Separation of Visible and Invisible Light.* **W. S. Andrews.** (Gen. El. Rev. 20. pp. 817–818, Oct., 1917.)—Wood has described a method for separating the invisible ultra-violet rays from the visible light of a mixed spectrum, and the present paper describes a simple apparatus based on Wood's idea. Light from a source rich in ultra-violet rays passes through a quartz lens and is brought to a focus, the focus for the ultra-violet rays being considerably nearer the lens than that of the visible rays. A diaphragm with a small pin-hole placed at the mean focus of the ultra-violet rays thus cuts off almost the whole of the visible rays, and a screen placed beyond the diaphragm will only have a small illuminated spot. This can be cut out by introducing a small metal disc between the pin-hole and the screen, the latter then only receiving ultra-violet light diverging from the pin-hole. The apparatus is well adapted for the study of fluorescence. A. W.

48. *Reflection of Light from Regularly-stratified Media.* **Rayleigh.** (Roy. Soc., Proc. 98. pp. 565–577, Oct. 9, 1917.)—The author observes that the

remarkable coloured reflection from certain crystals of potassium chlorate discovered by Stokes [Roy. Soc., Proc., 1885], the colours of old decomposed glass, and probably those of some beetles and butterflies, lend interest to the calculation of reflection from a regular stratification, in which the alternate strata, each uniform and of constant thickness, differ in refractivity. It is mentioned that in a crystal of chlorate described by R. W. Wood, the purity observed would require some 700 alternations combined with a very high degree of regularity. A general idea of what is to be expected is first arrived at by considering the case where a single reflection is very feeble, and this is followed by a detailed mathematical analysis applicable when the component reflections are more vigorous, or when the number of alternations is very great. G. W. DE T.

49. *Minimum Radiation Visually Perceptible.* **P. Reeves.** (Comm. No. 51 Eastman Kodak Co.'s Research Lab. Astrophys. J. 46. pp. 167–174, Sept., 1917.)—The author reviews various experiments computing the minimum visible radiation as determined by H. N. Russell [Abs. 767 (1917)] and others. The apparatus used for such tests by Nutting is described and consists essentially of a small aperture, behind which is a diffusing translucent screen, illuminated by an electric lamp, the light from which can be diminished within a wide range by means of neutral decimal filters and absorbent wedges. In this way an artificial star 1 mm. in diam. could be produced, the brightness being progressively diminished by manipulating the wedge until it was only just perceptible. The star was viewed at a distance of 3 mm. This minimum brightness is affected by various factors such as the area of the pupil-aperture and the state of adaptation of the eye, as well as the personal sensitiveness to light and condition of health of the observer. Ideo-retinal light, probably due to retinal circulation, may also hinder accurate observations. Measurements of pupil-aperture may be made by flashlight photographs in the dark, but wide variations are recorded. A table of observations by the author and other observers is presented. With a variation in area of pupil-aperture of 0·28 to 0·57 cm.² the minimum energy entering the eye necessary to produce an impression of luminosity, is found to vary between $7{\cdot}7 \times 10^{-10}$ and $38{\cdot}0 \times 10^{-10}$ erg. per sec. J. S. D.

50. *Experimental Demonstration of Constant Speed of Light from Moving Mirror.* **Q. Majorana.** (Comptes Rendus, 165. pp. 424–426, Oct. 1, 1917.)—If the velocity (c) of light is not changed by reflection at a moving mirror (v), it follows from Doppler's principle that its frequency and wave-length (λ) are affected by the factors $1 + v/c$ and $1 - v/c$ respectively. If, on the contrary, we admit that the speed of the reflected light is affected (hypothesis of Stewart, Thomson, Comstock and others), the new frequency is still affected by the factor $1 + v/c$ as before, while the wave-length now remains unaltered (λ).

These two cases correspond respectively to the second postulate of relativity, and to a sort of emissive or emanative theory of light, of which an example occurs in the critical study of W. Ritz.

The experimental test was as follows: The light from the mercury lamp (green line $\lambda = 546$) fell on mirrors carried on the periphery of a wheel 88 cm. in diam., rotating at such speed that the image in the last mirror was moving at about 450 metres per sec. The reflected light was examined by a Michelson interferometer which could detect a change in λ of a few millionths of itself. On the basis of constant speed of light, the calculated

displacement of the circular fringes at infinity was 0·71 of a fringe. The observed displacement was between 0·7 and 0·8. Hence the speed of light is not affected by reflection from a moving mirror. E. H. B.

51. *Physical Characteristics of the Elementary Grains of a Photographic Plate.* **M. B. Hodgson.** (Eastman Kodak Co.'s Research Lab., Comm. No. 56. Frank. Inst., J. 184: pp. 705–715, Nov., 1917. Abstract.)—The term "grain" is used to denote in a general way both the characteristics of the individual granular deposits of silver and the arrangement or agglomeration of these constituent particles as an entirety, with sometimes emphasis on one phase of the subject and sometimes on another. It is the purpose of the present paper sharply to differentiate between these two phases by outlining a few fundamental conceptions of plate-grain, also to present some of the more interesting data obtained in the study of the elementary particles of a silver-halide emulsion. There are present, in nearly all developed and dried photographic plates, deposits of silver of varying size and shape. On close examination it is found that these deposits are made up of small elementary units, which in a high-speed plate negative vary in size from the ultra-microscopic to five or six microns in greatest dimension, the average variation being from 0·2 μ to 4 or 5 μ, and the mean size about 2·5 μ. These elements are grains in the strict sense of the term, being to a certain extent isolated from each other by intervening walls of gelatine. In viewing a dried-down negative, however, by transmitted light, under moderate magnification or none at all, we see, not these isolated grains, but, in effect, agglomerations of grains by the projections of light through interstices between many grains in numerous "grain planes" throughout the emulsion layer. Therefore since the average layer is about six grains deep, and since the grains themselves are distributed on a probability basis in each layer, we obtain more or less regular large patches and chains of grains as a result, the pattern and regularity depending on the particular type of emulsion used. It is this granularity which makes up what is commonly meant in speaking of grain; it is the grain met with in projection work, in enlarging and in portraiture. This overlapping and agglomeration of grains can be seen by observing a horizontal plane view of a photographic film through the entire emulsion, in comparison with a thin vertical section through the same film. Silver bromide occurs, in the average emulsion, in the form of more or less regular semi-transparent crystals belonging to the isometric system, the most regularly recurring figure being the tetrahedron. The larger grains are evidently builds or aggregates of hemihedral tetrahedra or other imperfectly developed forms. In addition there are present numerous fragmentary and truncated particles. The physical characteristics of these grains seem to be dependent on the method by which the silver bromide is precipitated, on the temperature of precipitation, the amount of gelatine present, the concentration, and the presence of additional salts. The fragmentary grains are very numerous in nearly all emulsions. From the results of this investigation it seems logical to assume that the inner mass of the grain is pure silver salt; for when water strikes the unexposed crystals no swelling at all is observable, even under the highest power magnification. However, in the majority of cases, when development is complete, the silver deposit is vastly different in form from that of the parent crystal. During development the growing silver mass becomes twisted and distorted. This suggests strong external forces at work, probably due either to an adsorbed layer of gelatine or to almost perfect adhesion to the surrounding gelatine. In the silver bromide crystal, even when water is present in the system, this strain is

insufficient to break down the cohesion of the particles of the crystal and distort it, but when the spongy deposit of silver begins to form, in soot-like particles, the enveloping "bag" of gelatine more or less distorts it.

In the average high-speed plate this distortion is great, causing the developed grains to resemble black pop-corn or irregular chunks of coal. In no case of normal procedure has a curious phenomenon described by Scheffer been observed. Scheffer described and illustrated the development of silver-bromide grains under high-power magnification. He showed that in his specimens the grains shot out, or grew, feelers or tentacles during development. These tentacles were subsequently capable of affecting other silver-bromide grains, inasmuch as contact seemed to cause developability. In only one particular series of enormous over-exposures, developed under the arc illumination of the microscope, was such a phenomenon observed. Many illustrations of photomicrographs showing horizontal planes and vertical sections of emulsions, as well as stages in grain development, are given. In all cases of normal conditions, development seems to be more or less steady transition from silver salt to reduced silver, with the gelatine functioning to cause some distortion of the shape of the individual deposits. A. E. G

52. *Influence of Development on Photographic Stellar Images.* **F. E. Ross.** (Eastman Kodak Co.'s Research Lab., Abridged Sci. Publ. 2. No. 47. pp. 133–134, 1915–1916.)—Results are presented of an investigation made to determine (*a*) the differences in power of various developers in producing faint stellar images; (*b*) the differences in quality of stellar images with variations of developer, with special reference to the accuracy of measurement of their distance apart on the plate: very little difference could be detected in the power of different developers to produce images on the verge of invisibility. In the case of images of just barely measurable density, however, it was found that Process developer (hydroquinone and caustic alkali) developed the faint images to such blackness as to make them more measurable than in the case of any other of the developers examined. Regarding the accuracy of measurement factor, the results indicate that there is an apparent systematic error in the distance apart of two objects which depends upon the developer and that the greatest accuracy is obtained by developing with Process developer for two minutes. C. P. B

53. *Method of Line-Coordinates for Investigating the Aberrations of a Symmetrical Optical System.* **T. Chaundy.** (Phil. Mag. 34. pp. 496–509, Dec. 1917.)—The present application of line-coordinates to the theory of geometrical optics takes the standpoint of considering a typical ray of a beam of light passing through the optical system, regarding that ray as completely determined by knowledge of its six coordinates. The effect, then, of any series of refractions undergone by such a ray can be stated in terms of the contemporaneous transformations undergone by the coordinates of the ray. Since in knowing the behaviour of every ray in its passage through an optical system, we are in full possession of the geometrical facts of the system, it is clear that formulæ expressing the coordinates of a typical ray, at any stage of its passage, as functions of its coordinates before incidence, constitute a complete conspectus of the geometrical properties of the system.

The construction of such formulæ in the general case, though doubtless the ideal aim of the method, leads, of course, to results so unmanageable as to be of little value. The present paper therefore considers only the case of chief practical importance, namely, that of a symmetrical optical instrument con-

posed of media bounded by spherical interfaces with collinear centres in which only those rays are regarded whose inclination θ to the optic axis is small enough to require the retention of low powers only of θ.

This first paper then gives the mathematical outline of the method. Its applications to theoretical and practical problems are left to other papers.

E. H. B.

54. *Gas Interferometer Calibration.* **J. D. Edwards.** (Am. Chem. Soc., J. 39. pp. 2382–2385, Nov., 1917.)—In the Rayleigh-Zeiss interferometer for high-pressure gas analysis [see Stuckert, Abs. 390 (1910)] the difference in refractivity of two samples of gas is measured which are contained in two chambers. Two beams of light pass through these chambers and produce interference fringes; the path length is equalised by tilting a glass compensator plate in the one beam; when the temperature, pressure, or composition of the gas in one chamber is changed the fringes are shifted, and they are brought back to position by tilting the compensator through a measured amount. In calibrating the instrument one chamber is usually charged with a standard gas, the other with the same gas and various known percentages of the gas for which the instrument is to be calibrated; the method is laborious and no more accurate than the method of analysis of the mixture. L. H. Adams (*ibid.* 37. pp. 1181–1194, 1915) proposed calibration by calculation from certain constants. The method suggested by the author (Bureau of Standards) requires no special apparatus and only the knowledge of the indices of the gases to be used. Both chambers are filled with air (free of CO_2), and the pressure in the one chamber is reduced by known amounts. Assuming that the refractivity of a gas mixture is equal to the sum of the refractivities of each constituent multiplied by the percentage of it present in the mixture, which is approximately correct, the interferometer scale may be calibrated in terms of refractivity differences. The accuracy depends upon the gases, but is usually greater than with volumetric analysis, especially in the case of small percentages. H. B.

55. *Appearance of Colour Spectra to the Aged.* **R. B. Carter.** (Nature, 100. pp. 164–165, Nov. 1, 1917.)—During the latter months of the author's eighty-ninth year his attention was directed to a circular colour spectrum which appeared to surround any bright light to which his eyes were turned. If he looks steadily at an ordinary electric filament glow-lamp, about 10 ft. distant, it appears to be surrounded by a vivid colour circle about 2 ft. in diam., with the red band external, the blue internal, the yellow intermediate. The band appears to be about 6 in. in width, so as to be quite clear of the light itself, from which its inner margin appears to be about 6 in. distant. Round a lighted wax match held in the hand the colour circle appears to be about as large as a florin, while that around the full moon is very large and of brilliant colours. The author (who retired from practice 15 years ago) has come to regard the colour rings mainly as an accidental result of unimportant lenticular conditions, the effects of which are intensified by the use of electric light, but which may be dismissed from consideration so far as the quality or the maintenance of vision is concerned. E. H. B.

56. *The Faraday-effect in Non-ferromagnetic Metals.* **B. Pogány.** (Phys. Zeits. 18. pp. 422–428, Sept. 15, 1917.)—Voigt has shown [Abs. 1647 (1915)] from Ingersoll's observations of the Kerr-effect that the magneto-optic behaviour of Fe and Co in the ultra-red portion of the spectrum is determined by conducting electrons. The value 10^7 deduced from these obser-

vations for the internal magnetic field under which the electrons move is the same as that obtained by consideration of the Weiss theory of ferromagnetic metals. Since conducting electrons are present in non-ferromagnetic metals it occurred to the author that such metals should exhibit the Faraday-effect when under the influence of these large molecular fields.

A thin iron film (Fe_1) was deposited on a glass plate by kathode sputtering. Then a film of the non-ferromagnetic metal (X) to be examined was similarly deposited on one half of the plate, and finally the whole covered with a second iron film (Fe_2). The metals investigated were Pt, Pd, Cu, Au, and Ag. Light of wave-length 590 $\mu\mu$ was employed and the magnetic field was of the order 23,000 c.g.s. units. The rotation of the plane of polarisation was measured when the light passed (1) through ($Fe_1 + X^xFe_2$), and (2) through ($Fe_1 + Fe_2$). The rotation was also measured before the deposition of the second iron film so that the rotation $(Fe_1 + X) - Fe_1$ could be determined. Stepped films were also prepared so that the effect of film thickness could be studied. The results are given in a series of tables and curves which show the same general characteristics. It is evident that the thickness of the iron film influences the phenomena and this the author proposes to investigate further.

The general conclusion to be drawn is that the metal, whether diamagnetic or paramagnetic, shows a positive rotation somewhat smaller than that obtained for iron films. L. L.

57. *Theoretical Relations in the Interferometry of Small Angles.* **C. Barus.** (Nat. Acad. Sci., Proc. 3. pp. 563–565, Sept. 15, 1917.)—Further considerations regarding the method of long-distance measurement by displacement interferometry [see Abs. 924 (1917)]. J. W. T. W.

58. *Physical Properties of Carborundum.* **O. Weigel.** (Gesell. Wiss. Göttingen, Nachr. p. 264, 1916. Zeits. Instrumentenk. 37. 153–155, July, 1917.)—Small prisms were made from carborundum crystals and the optical constants determined at various temperatures. C. P. B.

59. *Diffraction at Metallic Screens.* **P. S. Epstein.** (Ann. d. Physik, 53. 9. pp. 33–42, Oct. 2, 1917.)—A mathematical investigation on the theory of this case [see Abs. 1248 (1915)]. **R. Schachenmeier.** (*ibid.* pp. 43–46, Oct. 2, 1917.)—Schachenmeier replies to Epstein and defends his own views of the subject. E. H. B.

60. *Absorption Glass for Optical Pyrometers.* **P. D. Foote, F. L. Mohler and C. O. Fairchild.** (Washington Acad. Sci., J. 7. pp. 545–549, Nov. 4, 1917.)—Shows that if the absorption coefficient of the glass at wave-length λ has the value $e^{(\alpha C_2/\lambda)}$, where α is constant with respect to λ, then $1/\theta - 1/S = \alpha$; θ and S being respectively the true and measured absolute temperatures of the black-body source as determined with the absorption glass in use. A combination of glasses possessing this characteristic has been found, the value of α remaining the same within the limits of experimental error, between temperatures of 1400° and 3000° abs. A further paper is to describe another glass for use with a tungsten-filament pyrometer lamp, taking into account the loss of light at lens surfaces and the emissivity of tungsten. J. W. T. W.

61. *Electric Double Refraction in Binary Mixtures of Liquids.* **C. Bergholm.** (Ann. d. Physik, 53. 10. pp. 169–176, Oct. 26, 1917.)—The author has determined the electric double refraction, the dielectric constant, and the index of refraction for binary mixtures of carbon disulphide and meta-xylol;

carbon disulphide and carbon tetrachloride; chlorbenzene and carbon tetrachloride; chlorbenzene and meta-xylol, and he also adds the values obtained by Schmidt (Abs. 841 (1902)] for carbon disulphide and chloroform. He finds that the peculiarity of electric double refraction in binary liquid mixtures can be explained only qualitatively by means of the mixture formula calculated according to Langevin's theory of electric double refraction, quantitative agreement being found only in a few cases. For most of the mixtures investigated exact validity is found for the formula—

$$B = \tfrac{1}{2}[1 + (k+2)^2(n^2+2)^2/(k_1+2)^2(n_1^2+2)^2] \cdot B_1V_1/(V_1+V_2) + \tfrac{1}{2}[1 + (k+2)^2(n^2+2)^2/(k_2+2)^2(n_2^2+2)^2] \cdot B_2V_2/(V_1+V_2),$$

where B is the Kerr constant, n the refractive index, k the dielectric constant, and V_1 and V_2 are the volumes of the constituents. A. F.

62. *Talbot's Bands and the Resolving Power of Spectroscopes.* **T. E. Doubt.** (Phys. Rev. 10. pp. 322–334, Oct., 1917.)—Describes a number of methods of obtaining Talbot's bands with various types of spectroscopic apparatus. Diagrams are given showing the position of the retarding plate for an ordinary single-prism spectroscope, a Hilger constant-deviation spectroscope, a concave grating, a plane grating, and an echelon. Several photographs of the various band systems obtained are reproduced. With the echelon, as the retarding plate is inclined from the perpendicular, the fringes are rotated with reference to the slit, and they appear as sharp at large angles as when parallel to the slit. The rotation may be increased until as many as 30 bands appear on the green mercury line and a like number on each of the yellow and blue lines. In some cases as much as 92 mm. of glass was used for retarding one of the beams. The fact that 1 mm. of glass produces one Talbot band for about 6 Å.U. in the region of the D-lines suggests that we have an objective standard of resolving power for spectroscopes. The glass used was soft flint, with an index of refraction of about 1·6. The latter part of the paper gives the theory of Talbot's bands. A. W.

63. *Resonance and Ionisation Potentials for Sodium Vapour.* **J. T. Tate and P. D. Foote.** (Washington Acad. Sci., J. 7. pp. 517–525, Oct. 19, 1917.)—The object of the investigation here described was the experimental determination of the critical potentials for electrons in sodium vapour. The experimental arrangement was identical with that used by the authors in their previous work on cadmium vapour, and the method of measurement was that already described for the determination of the critical potentials in mercury vapour [Abs. 1274 (1916)]. The results, which are exhibited graphically, show that electrons having a velocity corresponding to about 2·12 volts collide inelastically, without ionisation, with the atoms of sodium vapour. The energy lost by the colliding electrons is probably radiated in light of wave-lengths corresponding to the D-lines. Assuming this to be the case the theoretical value of the resonance potential is 2·10 volts. Electrons having a velocity corresponding to about 5·13 volts are able to ionise sodium vapour and cause it to emit a brilliant yellow light. The theoretical value of the ionising potential, using the limiting wave-length of the principal series in the sodium spectrum is 5·13 volts. The above results do not agree with results recently obtained by Wood and Okano [Abs. 1134 (1917)], who observed an emission of the D-lines at a potential of 0·5 volt, and the appearance of the subordinate series (probably indicating ionisation of the sodium

vapour) at 2·3 volts. A similar phenomenon has been observed by the author in connection with a determination of the critical potentials for electrons in potassium vapour. It was found that the first resonance collision occurred at an effective applied potential of 0·2 volt. In all cases, however, the second resonance collision took place at a potential 1·60 volts higher than the first. This value is exactly that required by Bohr's theory for the emission of the fundamental lines (λ7702 and λ7669) of the principal series of the potassium spectrum. Ionisation of the potassium vapour was observed at an effective potential of approximately 4·2 volts. The theoretical value corresponding to the limiting frequency of the principal series is 4·33 volts. [See Abs. 15 (1914).] A. W.

64. *Iron Arc free from Pole-effect for Wave-length Standards.* **C. E. St. John and H. D. Babcock.** (Nat. Acad. Sci., Proc. 3. pp. 505–507, Aug., 1917. Astrophys. J. 46 pp. 138–166, Sept., 1917.)—In the provision of a set of standard wave-lengths it is necessary that the light-source should be accurately reproducible by different observers, and it was soon found in connection with the work on International Standards that one of the most disturbing phenomena was the pole-effect, by which the wave-lengths of certain lines are markedly affected. A special study has been made of the pole-effect for iron, the determination being made with a plane grating spectrograph and also with interference apparatus, the light-source being derived from three different forms of arc. A type of arc is described which is free from pole-effect in a central zone at least 1·25 mm. wide, the current being 5 amps. at a length of 12 mm. The accuracy of measurement of difficult lines is greatly increased by the elimination of pole-effect, and it is then found that the wave-lengths of iron lines are found to be independent of the nature of the negative pole, whether that be of iron, carbon, copper, brass or chromium-steel. The sharpness of both stable and sensitive lines, when observed in a source free from pole-effect, is shown to be much greater than it is in the International arc. Attention is drawn to the misleading results which may be deduced from investigations in which this pole-effect has not been recognised. C. P. B.

65. *Band and Line Spectra of Iodine.* **R. W. Wood and M. Kimura.** (Astrophys. J. 46. pp. 181–196, Oct., 1917.)—Iodine vapour is of peculiar interest spectroscopically, in that it is one of the few substances which can be caused to emit line spectra of an almost infinite variety, of definite types and very regular structure, by excitation with monochromatic light. The present paper deals chiefly with the electrical excitation of the vapour in vacuum tubes. In the course of the investigation it was found that many of the lines of the line spectrum are complex under high dispersion, appearing as doublets, triplets, quadruplets and quintuplets, the total width of the group in the case of the quintuplet being about 0·35 Å.U. These complex lines behave in a most remarkable manner in the magnetic field. Owing to the action of iodine on the electrodes it was finally decided to employ external electrodes of tin-foil. The tubes consisted of two cylindrical bulbs, around which the tin-foil was wrapped, connected by a capillary tube. The action of high temperature on the band absorption spectrum was investigated, and it was found that the lines are affected in different degrees. Some lines are much stronger in the cold vapour than in the hot, while with others the reverse is the case. Many lines are of about the same intensity in both spectra. A table is given of the lines observed in the line spectrum, those showing a decrease of intensity a

a result of increasing the current density by a condenser or parallel spark-gap being indicated by an asterisk. The complex lines were studied with a 20-plate echelon, sometimes crossed with a plane grating. While some of the complex iodine lines showed an irregular structure, or appeared as close doublets, the majority exhibited a series of lines of four or five members, decreasing in intensity and separation toward the region of short wave-lengths. The structures of 25 lines are exhibited graphically. The line λ4474 shows a reversal of the series, decreasing in intensity and separation toward the region of long wave-lengths. The width of the quadruplet series λ5438 is only a little more than half the distance between the first two members of the quintuplet series λ5405, in which the separation of the members reaches its max. value. A. W.

66. *Zeeman-effect for Complex Lines of Iodine.* **R. W. Wood** and **M. Kimura.** (Astrophys. J. 46. pp. 197–205, Oct., 1917.)—The behaviour of some of the complex lines of iodine in a magnetic field has been investigated [see preceding Abs.], and it is found that the complex lines having the form of a series with decreasing intensity and separation, are not all affected in the same way. In the case of any given complex line the components are affected to very different degrees. Certain components may not be affected at all, while others break up into doublets, the components of which sometimes fuse with neighbouring components and sometimes fade gradually away as the field-strength increases. Further work will be undertaken with the object of tracing the development from weak to strong fields. For this work it seems probable that good results can be obtained with tubes provided with internal electrodes of Pt-foil covered with a thin layer of soft glass. With such tubes the capillary can be considerably enlarged and heavier discharge currents employed. [See Abs. 419 (1913).] A. W.

67. *The Fluorescence of Four Double Nitrates.* **H. L. Howes** and **D. T. Wilber.** (Phys. Rev. 10. pp. 348–357, Oct., 1917.)—Recently the question of the influence of water of crystallisation on the fluorescence and absorption spectra has been studied [Abs. 950 (1917)], but the matter has not been exhausted. A year ago the present authors made a brief study of seven forms of the sodium uranyl phosphate and concluded that only when crystals are found can a resolved spectrum be obtained by cooling; and the object of the present paper is to throw a little more light on the rôle played by crystal structure. The authors have failed to produce two crystals having different crystal systems but identical chemical formulæ, but have obtained two crystals with nearly the same formula and different crystal systems. The two pairs of double nitrates studied are $NH_4UO_2(NO_3)_3$; $(NH_4)_2UO_2(NO_3)_4$ $2H_2O$; $KUO_2(NO_3)_3$; and $K_2UO_2(NO_3)_4$. Both visual and photographic measurements of the spectra were taken. The relation between fluorescence and absorption series is of the same nature as that previously found to exist in the spectra of the uranyl salts. The study of related series is made confusing by the presence of absorption series extending into the fluorescence region; and, *vice versa*, many fluorescence series, if extended, fit absorption bands. A special study of the overlapping region is needed to determine better the relation between fluorescence and absorption series. In the study of the spectrum of the uranyl nitrate by Merritt [Abs. 950 (1917)], each fluorescence series has constant intervals between the bands, which are the same for all series; in the case of the absorption series, however, the interval is not the same for all the series. In the authors' study

of the double nitrates, it is found that there is an unmistakable variation the fluorescence intervals as well as in the absorption. The ratios of relat fluorescence and absorption intervals are nearly constant for the mo ammonium and mono-potassium uranyl nitrates, but differ in the case of t other two salts. The crystal system to which a salt belongs is certai an important factor in determining the position of the bands. This is sho by various facts, amongst others by the fact that although the chemi formulæ of the two potassium salts are more nearly alike than those of t two ammonium salts (one of which contains water of crystallisation), there is a greater difference between the third and fourth spectra than th is between the first and second spectra. A.

68. *New Secondary Radiation from Canal Rays.* **M. Wolfke.** (Ph Zeits. 18. pp. 479–483, Oct. 15, 1917. Paper read before the Schweiz. Natu forsch. Gesell., Zurich, Sept., 1917.)—Some years ago Chadwick and Russ [Abs. 489 (1914)] showed that α-rays can excite the characteristic γ-radiati of the heavier elements. The present paper contains a description of expe ments indicating that canal rays can excite characteristic X-radiation in similar way. In the cases of tin and lead it is shown that a penetrati radiation is produced when bombarded by canal rays. This effect w observed photographically and the X-radiation proved to be characteris of these elements. In the case of lead, a value of the wave-length of t radiation was determined at a particular value of the discharge voltage.

On the basis of Einstein's quantum law it seems probable that the ne effect accounts for the production of the lines in the L-series of bo elements. A. B. V

69. *X-ray Spectra of Isotopic Elements.* **M. Siegbahn** and **V Stenström.** (Comptes Rendus, 165. pp. 428–429, Oct. 1, 1917.)—It known, according to the work of Rutherford and Andrade, that the γ-r spectra of RaB and RaC show a marked agreement with the X-ray spect of their isotopes. On account of the difference in the method of measu ment of the wave-lengths in the two cases, it is difficult to form an estima of the accuracy of this agreement. It seems possible that the actual diff rence may be less than the limits of error in the experiments. A comparis of the X-ray spectra of radio-active substances with the X-ray spectra their isotopes appears to be more difficult than the analogous study of t X-ray spectra of different isotopes. Thus a study has been made of t X-ray spectra of the isotopes lead-RaG ; RaG existing in quantities suf ciently pure for a determination of its atomic weight.

The two spectra were obtained on the same plate under identic conditions, and measurements made of all the lines of the L-series a the strongest lines (α, β) of the M-series.

As a result of the measurements the authors conclude that the wav lengths of the X-ray spectra of the isotopes lead-RaG agree to with $0{\cdot}0001 \times 10^{-8}$ cm. approximately. A. B. V

70. *Analysis of Crystal Structure by X-rays.* **C. Runge.** (Phys Zeits. pp. 509–515, Nov. 1, 1917.)—A mathematical paper bearing principally on t work of Debye and Sherrer on the interference of X-rays produced by irregular distribution of crystalline particles [see Abs. 1140 (1917)].

A. B. V

HEAT.

71. *Evaporation from a Circular Water Surface.* **N. Thomas** and **A. Ferguson.** (Phil. Mag. 34. pp. 308–321, Oct., 1917.)—The rate of evaporation from a free circular water surface into a quiescent atmosphere was shown by Stefan to depend theoretically upon the radius of the surface, not upon its area. Experiments were made by the authors, both indoors and in the open air to test the dependence of evaporation upon the dimensions of the surface of evaporation, and upon the depths of the surface below the rims of the crystallising dishes containing the water which varied in radius from 2 to 10 cm. If E is the rate of evaporation and a the radius of a dish, then assuming that $E = Ka^n$, where K depends on external conditions, it is found that in practice n is never so small as unity, the value required by Stefan's result, but varies from 1·5 when the dish is brimful, to about 2·0 when the depth of the surface is 3 cm. or more below the brim of the dish. With the latter value, evaporation is proportional to the area of the evaporating surface, and the method of expressing amount of evaporation by depth of water evaporated is justified. With the former value of n the depth of water evaporated varies inversely as the square root of the radius of the dish.

R. C.

72. *Coefficient of Total Radiation of Uniformly Heated Enclosure.* **W. W. Coblentz.** (Nat. Acad. Sci., Proc. 3. pp. 504–505, Aug., 1917.)—In a former paper [Abs. 581 (1916)] an estimate has been given of the probable value of total radiation of a uniformly heated enclosure, or "black body." Further consideration has been given by introducing corrections for losses by reflections from the receivers, and also for the atmospheric absorption. The latter was determined by observing the transmission through a brass tube 6 cm. in diam. and 51 cm. long, the ends being provided with windows of rock-salt. Black-body radiation at 800° C. was passed through the evacuated tube and focused on a linear Bi-Ag thermopile. Immediately after a stopcock was opened to allow the entrance of either dried or undried air to enter at atmospheric pressures. The result is practically identical with the value calculated by Millikan, on the basis of recent determinations of Planck's element of action, from photoelectric measurements and from his redetermination of the electron.

C. P. B.

73. *Colour Temperature Scales for Tungsten and Carbon.* **E. P. Hyde, F. E. Cady,** and **W. E. Forsythe.** (Phys. Rev. 10. pp. 395–411, Oct., 1917.)—A fuller account of work previously reported [see Abs. 577 (1916)]. Corrections were made for (i) the selective absorption of the lamp bulbs, (ii) the cooling-effect of the leading-in and supporting wires, (iii) the absorption of the lamp bulbs. The value of the exponent β in the generalised form of the Stefan-Boltzmann equation $W \propto T^\beta$ is found to be fairly constant at about 4·02 for untreated carbon (T being the colour temperature) whereas for tungsten it varies from 4·9 or 5 to 4·6 over the range of temperature investigated (1750° to 2450° K.).

J. W. T. W.

74. *True Temperature Scale for Tungsten and its Emissive Power at Incandescent Temperatures.* **A. G. Worthing.** (Phys. Rev. 10. pp. 377–394, Oct., 1917.)—A full account of work previously briefly reported [see

Abs. 576 (1916)]. Preliminary investigations were made of (i) physiologic effects due to smallness of holes, (ii) the distortion in temperature distributio due to presence of holes, (iii) constancy of temperature over a given circum ference of the surface, (iv) effect of degree of polish of the radiating surface and (v) effective wave-lengths of the blue glass screens employed. Th method of correcting for the differences between the internal and externa temperatures is described. The results given in the present paper are base on a temperature scale in which 1336° K. is taken as the melting-point of gol and 14,350 $\mu \times$ deg. as the value of C_2. (This gives 1828° K. as the melting point of Pd.) The results given in the previous paper are revised to th scale, and a new table is given for the relation between temperature an emissive power between true temperatures of 1256° and 3433° K. the value at $\lambda = 0{\cdot}655\ \mu$ being for these temperatures 0·457 and 0·403 respectively.

J. W. T. W

75. *Critical Temperature and Pressure of Mercury and Phosphorus.* **J. J van Laar.** (K. Akad. Amsterdam, Proc. 20. 2. pp. 138–148, 1917.)—For th critical temperature and pressure of mercury the author calculates the value $T_k = 1172°$ abs., $p_k = 179$ atmos., and for phosphorus, $T_k = \pm 948{\cdot}1°$ abs. $p_k = \pm 80$ atmos.

A. F

76. *Temperature of Ignition of Gaseous Mixtures.* **J. W. McDavid.** (Chem Soc. J., Trans. 111. pp. 1003–1015, Nov., 1917.)—Methods for the determina tion of the ignition-temperature of gaseous mixtures have been classed by Dixon and Coward into 3 groups [see Abs. 855 (1909)], the experimental conditions governing this division being: I. A bulb containing the gaseous mixture, which is plunged into a bath maintained at a constant temperature. II. A mixture of the gases passed through a tube in a bath which is gradually being heated. III. The gaseous mixture being compressed adiabatically, the temperature of the mixture at the ignition-point may be calculated from the pressure required to ignite it. In each of these methods the gaseous mixture is retained in the state necessary for ignition for some considerable time, and it is quite possible, therefore, that before the ignition-temperature is reached a state of slow combustion ensues which generates sufficient heat to raise the remainder of the gaseous mixture to its ignition-point. Regarding the third method, Dixon and Coward point out that the temperature of ignition of a gaseous mixture under abnormal pressure may be totally different from that of the same mixture under normal pressure. Dixon and Coward's method is described, from which it appears advisable to eliminate so far as possible the time factor in determining the ignition-temperature, and it is also preferable to have a stationary volume of gas. The author now describes methods in which the time factor is practically eliminated, the temperature of ignition being taken to be that to which the gaseous mixture must be heated by application of a hot body so as to cause instantaneous ignition. In the present experiments the ignition temperature has only been determined for various gases when mixed with air. The essence of the method employed, of which details are given including all the variations made, consists in the ignition of a small volume of the gaseous mixture contained in a soap-bubble by means of an electrically heated wire or other red-hot body, the temperature at which ignition just takes place being noted. The gases employed were :—Coal gas, ethylene, hydrogen, carbon monoxide, petrol (fraction 0 — 80°) benzene, and ether, each being mixed with air. The paper contains 13 tables of results. An interesting fact is that pure methane when

mixed with air does not ignite below 1000°, but when hydrogen is introduced the ignition temperature is lowered. It was found that by enlarging the size of the bubble the mixture could be made to ignite at an apparently lower temperature; by reducing to about 3·7 cm. diam., however, instantaneous ignition occurred. H. H. Ho.

77. *A Re-determination of the Heat of Vaporisation of Water.* **J. H. Mathews.** (J. Phys. Chem. 21. pp. 536–569, Oct., 1917.)—The author has re-determined the heat of vaporisation of water, using the method devised by Richards and the author [Abs. 902 (1911)]. The apparatus employed has been improved more especially by the substitution of a vaporiser made of transparent quartz for those made of glass; and a better type of adiabatic calorimeter has been introduced. The water equivalent of the calorimetric system having been accurately determined, the author found that the heat required to vaporise 1 true gm. of water into a vacuum at 100° is 539·0 cals.$_{15°}$. Using another value of the water equivalent of the apparatus determined by an electrical method, the value for the heat of vaporisation was found to be 540·0 cals.$_{15°}$, a number which is in good agreement with that obtained by Smith, namely 540·7 cals. A. F.

78. *The Nernst Theorem and the Thermal Expansion of Solid Bodies.* **M. B. Weinstein.** (Ann. d. Physik, 53. 9. pp. 47–48, Oct. 2, 1917.)—In a former communication [Abs. 520 (1917)] the author has shown that on the Planck view of Nernst's theorem it does not of necessity follow that the thermal expansion of bodies, for which the theorem is valid, is nil at the absolute zero of temperature. In the present paper the author proceeds to deduce the same result from Nernst's exposition of his own theorem. The author refers to his own work on the equation of state for solid bodies, where a similar result is found for many substances. Reasons are given why Nernst's statement of his own theorem is considered preferable to that of Planck. H. H. Ho.

79. *On the Nernst Theory of Heat.* **P. S. Epstein.** (Ann. d. Physik, 53. 9. pp. 76–78, Oct. 2, 1917.)—Weinstein has recently [Abs. 520 (1917)] investigated Planck's explanation of Nernst's Theory of Heat. This he has modified to the extent of finding that the entropy of a condensed body at absolute zero is not an absolute constant but may be dependent on the pressure. The present author now puts forward a thermodynamical exposition of this proposition, and this points to Weinstein's assumption being incompatible with the second law of thermodynamics. H. H. Ho.

80. *Kinetic Theory of Rigid Molecules.* **Y. Ishida.** (Phys. Rev. 10. pp. 305–321, Oct., 1917.)—The author starts with a partial differential equation which Boltzmann has shown may be employed to investigate the behaviour of a monatomic gas, the gas being considered as an ensemble of the same kind of monatomic molecules, viz.,

$$\partial f/\partial t + \xi\partial f/\partial x + \eta\partial f/\partial y + \zeta\partial f/\partial z + X\partial f/\partial\xi + Y\partial f/\partial\eta + Z\partial f/\partial\zeta = J,$$

where f is the number of molecules per unit cell; x, y, z; ξ, η, ζ; X, Y, Z, are components of three-dimensional space, velocity, and acceleration respectively, and J is the rate of change due to encounters. Extended to any number of dimensions this becomes $\partial f/\partial t + \Sigma\partial(f\dot{x}_i)/\partial x_i = J$, where the x's are any coordinates specifying the system of the individual molecule. These molecules are assumed to be rigid bodies having no spherical symmetry, so

that the orientation and angular velocity of each individual molecule w have to be considered in addition to its space coordinates and translatio velocity. The space coordinates and coordinates specifying the orientati are classified as *immune* if unaffected by an encounter, and *affected* if affected. Further, any function of the latter, such that the sum of such fu tions for any two colliding molecules is the same before and after a collisi between them is called an invariant of the encounter. Then for invaria there will be three additional equations stating the conservation of mom of momentum. A series of equations which may be regarded as analog to six-dimensional hydrodynamical equations is then obtained, from which t angles of orientation are integrated out, leading to suitably modified eq tions corresponding to those of ordinary hydrodynamics, together wit vector equation corresponding to the conservation of moment of momentu which suggests the possibility, in a gas so constituted, of gyroscopic di turbances besides the sound-waves. The function f, which may be call the *distribution* function, is then found to be a function of thirteen variabl including the time, and is assumed to be continuous in all the variabl It is then found that binary encounters between molecules fulfilling t preceding conditions, so that they may be considered as behaving, so f as such encounters are concerned, as rigid bodies, can be specified by fi parameters, and that consequently there will be twelve variables, with seve invariants and five parameters of encounters, thus forming a complete syste in the sense that all the independent invariants have been utilised. The for of the distribution function is determined, and leads to the conclusion th a gas consisting of molecules of the type considered will obey the Boyl Charles law. G. W. DE T

81. *Contribution to the Determination of Gaseous Equilibria.* **W. D Treadwell.** (Archives des Sciences, 44. pp. 372–373, Nov., 1917. Pape read before the Soc. Suisse de Chimie.)—Adopting the principles of thermo dynamics put forward by Nernst and Planck, the author points out th constant a_g in their equations represents a characteristic energy-constant fo all real gases, and at sufficiently low temperatures the value of a_g in thei equations represents a characteristic energy-constant for all real gases, an at sufficiently low temperatures the value of a_g can be deduced from th properties of the gaseous phase without recourse to the theorem of Nerns For this constant the author deduces the expression : $a_g = Rl_np - c_pl_nT + ro/T$ Further, if A represents the work which is done by a saturated vapour i expanding isothermally and reversibly to zero pressure, the author deduce the rule *lim* $A/r = 0$, a rule analogous to the theorem of Nernst. The observed energy-constant a_g affords a measure of the deviations from the ideal state. Considered in relation to these deviations, the determination of vapour-pressure curves assumes a remarkable importance. A. F.

82. *An Electron Theory of Temperature Radiation.* **H. Nagaoka.** (Math. Phys. Soc., Tōkyō, Proc. 9. pp. 200–206, Oct., 1917.)—Recent experiments on electric conductivity of metals lead to the conclusion that in the motion of conducting electrons, the law of equipartition of energy holds only at high temperatures, while at low temperatures the deviation is quite pronounced. It is therefore necessary to modify most of the theories based on the assumption that the mean kinetic energy of electrons is proportional to the absolute temperature. The expressions for the absorption and emission of metals, deduced from the law of equipartition, must therefore be

altered, and consequently the electron theory of radiation will be somewhat affected. A simple and ingenious theory of temperature radiation based on the motion of electrons and Kirchhoff's law of emission and absorption was advanced by H. A. Lorentz. Based on the assumption that the mean kinetic energy of electrons is proportional to the absolute temperature, the result coincides with that deduced by Rayleigh and afterwards by Jeans. The fact that the above law holds only for long and not for short waves may be due to the quantum character of the energy of electrons. The present paper contains an attempt to extend the electron theory of radiation so as to include Rayleigh and Wien's law, by borrowing a theorem of the quantum theory, successfully used by Einstein and Debye in deducing the expression for the specific heat of solids, which has borne rich fruits and stood the test of experiments. An advantage of electron theory seems to lie in avoiding the hypothesis as regards the quantum emission and continuous absorption of oscillators. Ingenious as is Planck's deduction of the law of radiation, we are not in the least warranted to assume that the rate of absorption is constant. While the latter is approximately constant, it is in reality subject to small fluctuations, which are suppressed in his deduction of the law, by taking mean values. In addition the ratio of the probability of no emission to the probability of emission is assumed to be proportional to the intensity of the exciting radiation and for its evaluation the oscillator has to be assumed as similar to a Hertzian exciter. The latter hypothesis may b considered as plausible, but the discontinuity of emission and continuity o absorption is a point which still requires careful inquiry. The deduction of the law independent of such refuted hypothesis is worthy of consideration and is dealt with in the paper. The experimental test of the law of temperature radiation was only conducted in regions bordering both sides of visible light, so that the radiation given out at very low temperatures has not yet withstood the test of experiments. The author regards it as problematical whether the law of radiation will be confirmed for long and short waves as for visible light. H. H. Ho.

83. *Equilibrium Temperature of a Body exposed to Radiation.* C. Fabry. (Journ. de Physique, 5. pp. 207–218, May–June, 1916.)—A body exposed to radiation attains an equilibrium temperature which depends upon the energy received from the radiation and that lost during the same interval. The amount of the temperature-rise before equilibrium ensues is connected with the absorbing properties of the surface, and the energy absorbed is a maximum when the surface is black. It by no means follows that the black surface gives the most elevated temperature of equilibrium, since such a surface has the max. radiation as well as absorptive capacity. When the absorption is only partial but yet selective, and when radiation is the only cause of energy loss, then equilibrium temperatures can be obtained which are much more elevated than that of the black body. Before establishing the equation for the general case the author first considers a simplified example, deducing a formula $T=(P/\eta\sigma)^{\frac{1}{4}}$, where T is the equilibrium temperature of a body isolated in space and only capable of receiving solar radiation while unable to lose energy except by radiation, η is the ratio of the surface of the body to the right section of the incident radiation pencil intercepted, and σ the constant in Stefan's law. He then shows that for a grey surface, where partial though not selective absorption takes place, no change ensues, since the energies absorbed and radiated are multiplied by a common factor. Where the absorptive power is a function of the wave-

length the equilibrium temperature may be less or greater than that of the black body. In the latter case, if it be assumed that the absorptive power of the body has one constant value a, for the rays of the solar spectrum (short wave-lengths) and another constant value a_2 for the region of greater wave-lengths, then $T = (P a_1/\eta\sigma a_2)^{\frac{1}{4}}$, where P is the intensity of the solar pencil. For a black or grey body $a_1 = a_2$, for a white body $a_1 < a_2$ and the equilibrium temperature falls, while for a metal $a_1 > a_2$ and the temperature rises. The conditions at the surface of the earth next receive attention, since the presence of the air introduces by convection a loss of energy independent of the nature of the surface, while neighbouring objects and the atmosphere behave almost as an enclosure at uniform temperature. The general expression for the equilibrium temperature is next established as—

$$\eta \int_0^\infty \phi(\lambda) F(\lambda, T) d\lambda = \int^\infty \phi(\lambda)\psi(\lambda) d\lambda,$$

where $\phi(\lambda)$ is the absorptive power, $\psi(\lambda)d\lambda$ he radiation received between λ and $\lambda + d\lambda$, both being expressed as functions of the wave-length, and $F(\lambda,T)$ the function of the radiation of the black body which gives for each temperature the curve of radiant energy per surface unit. The special cases of black or grey bodies and those having only a single absorption band are then discussed. Finally the influence caused by the distance of the radiating source is considered. The author concludes his paper with an examination of ideas in connection with the temperature of space.

H. H. Ho.

84. *A Simple Calculation for the Theoretical Functional Determinant of a Gas and its Geometrical Significance.* **H. Rothe.** (Ann. d. Physik, 53. 10. pp. 151–162, Oct. 26, 1917.)—The functional determinant is of importance in the kinetic theory of gases, and although its value, which is equal to -1, has been determined by Boltzmann, Lorentz, and others, yet their procedure has involved complex mathematical treatment. The author now presents a short and simple process for its direct calculation. The geometrical significance of the functional determinant is next discussed, and Boltzmann's previous geometrical interpretation is shown to be invalid.

H. H. Ho.

85. *Thermodynamics of the Throttle-valve.* **M. Jakob.** (Phys. Zeits. 18. pp. 421–422, Sept. 15, 1917.)—This paper is a discussion of a previous communication by R. Plank [see Abs. 146 (1917)]. From his formula (1), namely :

$$v/T = c_p^0/10^4 \,.\, A \,.\, \int 1/T^2 (\delta A/\delta p)_T dT + f(p),$$

Plank derived the following equation of state (2) for the air :—

$$v = RT/10^4 \,.\, p + 0{\cdot}0103\ (8{\cdot}9/T^{-7833}/T^2 + 15p^2/T^3),$$

and then deduced an expression (3) for the cooling produced during reduction to atmospheric pressure by the throttle-valve :—

$$\Delta = -17{\cdot}8_p/T^{+2350p}/T^2 - 20p^3/T^3.$$

Schames has shown [*Ibid.* p. 30, 1917] equation (2) to give false values for the volumes, and Plank's reply to his criticism [Abs. 314 (1917)] was that his empirical equations only held in the region of $-100°$ to $0°$ C., and from $70°$ to $200°$; even within this zone, however, v deviates too strongly from observation values and at the higher pressures by over 10 %. Schames

has not supplied the cause of this variation in equation (1), and in the present paper this is shown to be essentially due to the assumption made by Plank for $f(p)$. In order to modify formula (1) so as to hold between wide limits, equation (3) must be suitably replaced by one of greater validity. Plank's assumption that $f(p) = R/10^4 p$, is found to be only correct when the conditions are those for a perfect gas. The author evolves a value for $f(p)$ which gives results correct in practice to 1 %. Schames's criticism is also met by a suitable modification of equation (3). H. H. Ho.

86. *A Determination of the Planck Radiation Constant C_2.* C. E. Mendenhall. (Phys. Rev. 10. pp. 515–524, Nov., 1917.)—The cross-connections of Planck's radiation theory give an importance and interest to its constants which is sufficient excuse for devoting a considerable amount of time to their accurate determination. The work described in the present paper involves some novelties of method and conditions and some refinements of observation which it is hoped have led to an increase in final accuracy. The work is discussed in two parts, in both of which, however, the same method has been used, namely, that involving the measurement of the ratio of the intensity of emission for a known wave-length at known temperatures. In the first part of the work a graphite tube furnace was used, and T_2 (2705° K.) was determined from T_1 (1604° K.) by the use of the Stefan-Boltzmann law. For the general arrangement of the furnace and some of its attachments see Abs. 1851 (1914). Using Wien's expression for the ratio of the intensities, namely : $\log\left(\frac{E_{T_2}}{E_{T_1}}\right) = \frac{C_2}{\lambda}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$, the methods used for determining the quantities λ, E_1/E_2, T_1, and T_2 are first considered in great detail together with the possible sources of error.

In the second part of the work the method used was the same in principle but applied directly between the melting-points of gold and palladium as determined by the wire method. This simplifies the temperature measurements, but the temperature range is so much less that the temperatures must be known with greater accuracy, and the intensity of emission is so low at the gold point that photometric balancing is far less accurate. This work, however, was only carried out as a check on that already described, to show that the value of C_2 obtained above was consistent with observations at the temperatures. The various elements of the problem are briefly discussed and the results given. The relation of C_2 to other constants is next dealt with ; these relationships are :—

$\lambda_m T = C_2/4{\cdot}9651$, $h = aC_2^4/48\pi ac$, $k = aC_2^4/48\pi a$, where $a = 4\sigma/c$ = constant of total radiation ; h = Planck's quantum constant, k = Planck's probability constant, $a = 1{\cdot}0823$, and c = velocity of light. H. H. Ho.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICI

87. *Electromagnetic Field of a Constant Current-element in a Biaxial An tropic Medium.* **M. Brillouin.** (Comptes Rendus, 165. pp. 555–557, Oct 1917.)—Up to the present no one has succeeded in obtaining the expres for the electromagnetic field produced by any source in a biaxial med The form of the wave surface has been discovered but not the distributio the amplitudes. The chief difficulty is that the formulæ proposed pre some discontinuities when applied along the optic axes. In this note author presents the result as obtained by a direct and classical method fo very simple primary case, namely, that of an electric doublet placed at origin of coordinates, whose moment varies proportionally to the time; current element which unites one of the electric masses to the other is t constant. After devoting a considerable amount of space to notation, author deduces a differential equation for the magnetic field in which difficulty of integration, so as to avoid singularities along the optic axis overcome and a solution presented. From this expression for the magn field of a current-element, there may be written immediately, in the form a simple integral, the magnetic forces due to a circuit of any form whatev traversed by a uniform and constant current. It suffices merely to add up t magnetic forces due to all the elements. The circuit may be closed in whi case the electric field is constant; or open and terminal by two capacit whose charge grows proportionally to the time, when the electric field obtained in like manner by addition of the electric fields due to each of t elementary doublets. H. H. H

88. *Mechanical Theories of the Electromagnetic Field.* **A. Korn.** (Phy Zeits. 18. pp. 504–507, Nov. 1, 1917.)—This paper deals with the transfo mation of the equations of the electromagnetic field, in which some fund mental differences from the equations in Lorentz's theory are pointed ou Reference is made to previous work [see Abs. 1071 (1917)]. The auth claims that his theory, as sketched in the paper, enables a mechanical pictu of the electromagnetic field to be obtained; also that the Fizeau and Morle Michelson experiment may be explained without the aid of so complicat an instrument as the Einstein-Minkowski relativity hypothesis. Goo agreement is claimed with the ideas of Faraday and Maxwell. H. H. H

89. *On the Theory of Electrodynamics.* **R. Malmström.** (Phys. Zeit. 18. pp. 454–456, Oct. 1, 1917.)—A difficulty which arises in every theory o electromagnetic processes with respect to moving bodies, is that the experi ments both of Fizeau and of Michelson must receive explanation. It follow from the former that ponderable matter does not carry the ether with when in motion, and so the acceptance of an absolute stationary ether necessitated. If this be the case, it is only a matter of accuracy to establis motion relative to the ether. This was the object of Michelson's experimen and from the negative results obtained it followed either that there is n motion relative to the ether, or, that such is incapable of being experimentall established. Lorentz, to explain the latter, assumed that every body b virtue of its motion undergoes dimensional change in the direction of motion

while Einstein has attained the same standpoint by the introduction of a new time idea. Since the latter idea is bound up with other physical fundamentals, it is therefore possible to evolve a consequent physical system in which all expressions connected with the time idea must undergo corresponding change. Relating to the above, Ritz has developed a theory in which the active forces between the electrons depend only on the relative velocities, and he regards every electron as attached to a material particle possessing the velocity of light, and radiating according to the laws of relative motion, the force at every particle being proportional to its density. Since only activity is assumed between the electrons, Fizeau's experiment remains unexplained, and, since the particles after loss of the electrons move according to the laws of gravitation, the theory is inapplicable to optics. The present author now submits another theory for the removal of the apparent contradiction between the experiments of Fizeau and Michelson. If the fundamentals of the Lorentz electronic theory be accepted, this will involve the assumption that all electromagnetic processes are to be traced to the activity of electrons, and the two facts to be explained are : (1) If ponderable matter moves in a field of oscillating electrons, the ether remains at rest ; (2) if a source of light (an oscillating electron) moves, then the propagation of light follows as if the light-source carried the ether with it. These two apparently contradictory facts can be reconciled by the assumption that there is not one unique ether, but that every electron possesses an ether which it carries with it during motion. Since ether in the electromagnetic sense is a polarisable body without mass, there is nothing absurd in the assumption. In a corresponding mechanical theory on the other hand, the mass of the ether must be finite, and the density inversely proportional to the fourth power of the distance from the electron. Such an ether would correspond better with the atomic hypothesis. The conditions now to be fulfilled are that the radiation only depends on the acceleration, and that the reciprocal activity of two electrons only depends on their relative motion. The first condition involves the removal of the absolute velocity term from the Lorentz expression for the field strength of an electron, with suitable modifications for the remaining terms. The second condition involves the aid of Riemann's fundamental proposition. The paper includes a mathematical exposition of the author's theory based on these assumptions. An expression for the field strength of an electron in the ether has been tentatively obtained by a combination of the elementary laws of Riemann and Lorentz which correctly explains all electromagnetic phenomena with the exception of the β-radiation. In order to account for the latter, the theory must be further extended. H. H. Ho.

90. *Theory of Variable Electrical Systems.* **H. W. Nichols.** (Phys. Rev. 10. pp. 171–193, Aug., 1917.)—The systems considered are those in which the ordinarily invariable elements—resistance, inertia or inductance, stiffness or capacity—are subject to variation in a general way. They have received little study from a general standpoint, although such important applications as electric signalling often depend on the variability of such an element. The problem is usually to find the effect upon a steady or quasi-steady state, of changes in some element, and often the steady state itself may be ignored, although not the energy transformed from it by the variable elements. It may be formally stated as follows :—An electrical system dynamically expressible in terms of a Lagrangian and a Dissipation function of the usual type operates subject to given impressed forces, and is disturbed by changes in an inertia, resistance, or stiffness element, and the disturbed

state alone considered, provided that the steady motions are of certain different from those of the disturbed state. It is found that energy c this way be added to the disturbed state in a method similar to that in v it is "lost" from a dynamical system by transformation to a type with w the purely dynamical problem is not concerned, namely, the energy of th agitation of systems whose coordinates are not required to be included i Lagrangian function in order to obtain a satisfactory solution of the l scale dynamical problem ; *e.g.* an ordinary electric bell may be regard simply a generator of oscillations, either electrical or mechanical, wi energy supply at the frequency of the oscillations, and deriving its e from a source which may be ignored if oscillatory states only are of int

The author classifies such systems into four types : (1) Purely elec systems, *i.e.* those whose motions do not involve the change of a mecha coordinate, and those in which the variables are measured from equilib positions, the generalised displacements x_1 being small, are characterise Lagrangian and Dissipation functions which are homogeneous, quad functions of the displacements and velocities, and have constant coefficie The differential equation of motion are therefore linear equations of the f $S_{11}x_1 - S_{12}x_2 - S_{13}x_3 = e_1$, where the e being impressed forces, are g functions of t, and any stiffness operator is of the form $S = lp^2 + rp$ where $p = d/dt$. This system has the operational determinant $[S_{11}$ symmetrical, and satisfies the energy principle. Hence, if C_{jk} be operator which finds the displacement x_j from unit driving force at the plac or the mutual compliance between j and k, $C_{jk} = D_{jk}/D$, where D is operational determinant of the system, and D_{jk} its minor. Now when u driving force is located at j it produces at k the symbolic displacem $C_{kj} = D_{kj}/D$, and $D_{jk} = D_{kj}$, so that the two mutual compliances are the sa Such a system has been called bilateral. Further, since the coefficients constant, if the driving forces are periodic, and are resolved into th Fourier components, all these will in general appear in the particular soluti for any x, and no others will appear, which may be expressed in the sta ment that the system cannot change the type of driving force. (2) When t coordinates of interest are the small departures from zero values in a state motion, the Lagrangian function is no longer homogeneous quadratic, but lea to equations of the form $S_{11}x_1 - (B_{12} + C_{12})x_2 - (B_{13} + C_{13})x_3 - \ldots = e_1$, etc., which C_{jk} has the form $R_{jk}p = R_{kj}p$. If the k^{th} equation is multiplied by p and the results added, the terms in C disappear and so do not enter into t equation of activity. The reciprocal theorem $D_{jk} = D_{kj}$ no longer holds, b the type of driving force remains unchangeable. The C's are of odd ord in p, and contribute odd order terms to the minors of D, but not to I These centrifugal terms correspond formally to mutual resistances, b differ from ordinary dissipative terms in that they occur in pairs in such way that in the absence of true resistances D will be of even order in suggesting that true resistances may be compensated by similar terms, an the conditions under which this is possible are discussed. Evidently, whe this is possible, there must be a transformation of energy from that of a ignored type of driving force. Just as energy dissipated as heat is not los but transformed into a type ignored in purely dynamical-electrical problem so energy may be thought of as entering the system from an ignored sourc through suitable devices for changing its type into one with which th problem is concerned, and the main object of the paper is the investigatio of systems in which this occurs. (3) When the differential equations ar linear, but with coefficients which are functions of the time, the system ca

execute motions whose types differ from those of the driving force, *i.e.* the particular solutions no longer correspond in component frequencies, with the driving forces. If then some driving forces are of ignored types, because, *e.g.* without direct influence on certain parts of the system, it is possible to supply energy in a way similar to that in which it may be dissipated as heat. When no energy is transformed to ignored types, the particular solutions depend upon the then purely imaginary roots of $D = 0$. (4) When the differential equations of the system are non-linear, the principle of superposition no longer holds. Non-linearity is often found to mean that all the mechanism of the system has not been taken into account.

The systems with invariable elements (1) and (2) are very briefly treated, to collect some useful results, the paper being mainly devoted to the investigation of the other two types—systems with variable elements, the principal object being to show how the transformation of energy from one type to another may lead to useful results. It is noted, however, that the most important variation is that in which the magnitude never departs from a mean value, and in cases of physical interest it is then possible to find a solution in the form of a convergent series, as has been done, *e.g.* by Barkhausen, Pupin, and others, using a method of successive approximation. It is found that the only variations not already taken account of in the ordinary equations of motion are those in which a permeability, density, dielectric constant, elastic constant, or resistance is changed. These are, therefore, the ways in which energy can be transformed from the sources of the undisturbed state. The general theory is exemplified by detailed investigation of two simple cases—the "microphone hummer," used for producing small alternating currents in the laboratory, and the "howling telephone," formed by holding an electrically-connected telephone transmitter and receiver together—the dynamical connection between the receiver diaphragm and the variable element consisting of a column of air, assumed in the investigation to move in one dimension only. G. W. DE T.

91. *On the Thick Rectangular Plate charged at its Centre, and the Corresponding Thin Plate.* **Mesnager.** (Comptes Rendus, 165. pp. 551–553, Oct. 22, 1917.)—The author has previously given the solution of the thick plate when charged at its centre [Comptes Rendus, 164. p. 721, 1917], and now deals with the parallel problem of the thin plate. The paper is entirely mathematical and must be consulted for any information. H. H. Ho.

92. *Experiments on Tribo-electricity. I. The Tribo-electric Series.* **P. E. Shaw.** (Roy. Soc., Proc. 94. pp. 16–33, Nov. 5, 1917.)—The term "Tribo-electricity" is used as an equivalent for frictional electricity. It is well known that the electrical effects obtained by rubbing together different substances are often irregular, and lists of substances, as arranged in series by early observers, differ very much from one another. With the object of elucidating this matter the author has made experiments on a large number of substances, in which the surface conditions and temperature were varied. These substances he arranges as shown in the Table, any material in the list becoming positively electrified when rubbed by one lower in the series. The normal positions are shown in col. 2; their altered positions, when the conditions are varied, in cols. 3, 4, 5, 6, 7. The series is divided at 14 into two groups, A and B. If under varied treatment the position of a substance alters in the list, then those substances in group A all move in one direction while those in B move in the opposite direction. The behaviour of Hg is anomalous.

When rods of materials are gently pushed into the mercury they all b positively electrified except celluloid and indiarubber. If, however, t plunged quickly into the mercury (Hg′) or stirred in it, then with the tion of asbestos they are negatively electrified.

	Place.	Materials in Normal Series.	Prepared Matt Surfaces.	Abnormal. Heated to a Critical Temperature.	Pressed Hot, Heated to about 150°, Pressed between Two Sheets of Similar Material and withdrawn.	Convex
		+				
	1	Asbestos (sheet)				
	2	Rabbit's fur, hair (Hg′)				
	3	Glass (combn. tubing)				
	4	Vitreous silica, opossum's fur				
	5	Glass (fusn.)	—	—	Mica	—
	6	Mica				
	7	Wool		—	—	Mica
	8	Glass (pol.), quartz (pol.), glazed porcelain				
A	9	Glass (broken edge), ivory				
	10	Calcite	—	Wool	Zn	
	11	Cat's fur				
	12	Ca, Mg, Pb, fluor spar, borax				
	13	Silk				
	14	Al, Mn, Zn, Cd, Cr, felt, hand, washleather	Calcite	Silk Cd (200°)	—	F. paper
	15	Filter paper				
	16	Vulcanised fibre	V. fibre	Ca (240°) ?	—	—
	17	Co ton	—	Calcite (270°)		
	18	Magnalium	Mica			
	19	Potash alum, rock-salt, satin spar	Woods V. silica		F. paper	
	20	Woods, Fe	Quartz	—	Woods	
	21	Unglazed porcelain, sal-ammoniac	Glass Combn. tube	Vulc. fibre (70°) Ebonite (100°)		
	22	Potassium bichromate, paraffin, tinned iron		Pb (240°)	—	Cork
	23	Cork, ebony	—	Al (240°) Zn (220°	—	—
	24	Amber	—	Fe (200°)		
	25	Slate, chrome alum	Sealing-wax Resin Shellac	—	Cork	
B	26	Shellac, resin, sealing-wax		Vit. silica (245°) Glass (245°) Mica (270°) Quartx (300°) Brass		
	27		Ebonite	Ni (200°) Sb (230°) Sn (210°) ?	—	Ebonite
	28	Ebonite	—			
	29	Co, Ni, Sn, Cu, As, Bi, Sb, Ag, Pd, C, Te, eureka, straw, copper sulphate, brass	—	—	Ebonite	—
	30	Para rubber, iron alum	— —	Celluloid Au (130°)		
	31	Guttapercha	—	Pt (130)		
	32		Celluloid Sulphur	Indiarubber		
	33	Sulphur				
	34	Pt. Hg. Au	—	—	—	Celluloid
	35	Celluloid				
	36	Indiarubber	—	—	Celluloid	—

The author considers that the prevalent idea, that the electric double lay existing at the surface of solids has the — layer outermost in all cases, incorrect. Normally the materials in Group A would have — outermo those in Group B having + outermost. Orientation of surface atoms woul

give rise to changes in the disposition of the two electric layers, and so account for the observed effects. L. L.

DISCHARGE AND OSCILLATIONS.

93. *Photoelectric Sensitivity of Various Substances.* **W. W. Coblentz** and **W. B. Emerson.** (Washington Acad. Sci., J. 7. pp. 525–532, Oct. 19, 1917.)—The paper gives the result of an investigation of various substances: (*a*) for an increase in electrical conductivity caused by the action of light upon them, and (*b*) for electrical discharging activity when they were charged to a negative potential in an evacuated chamber and exposed to light.

No change on exposure to light was observed in the electrical conductivity of tellurium, boleite, bismuthinite, and mixtures of the sulphides of lead and antimony. An increase in electric conductivity on exposure to light was observed in crystals of selenium, stibnite, boulangerite, jamesonite, and silver sulphide. Experiments are described in which crystals of bismuthinite were joined through a battery to the grid circuit of an audion amplifier and telephone. A change of current in this circuit affected the telephone. The light stimulus was interrupted by a rotatory sectored disc, as used in Bell's selenium photophone. When using a cell or crystal of selenium the fluctuations of light intensity produced a sufficient change in conductivity to cause a musical note in the telephone. Similarly stibnite gave this effect, but much feebler. In the latter case it was demonstrated that it was not a true photoelectrical change in conductivity, but is essentially a thermal effect. The same results (and of same strength as selenium) were obtained when heat radiation fell on a smoked strip of gold-leaf in the telephone circuit.

A. B. W.

94. *The Emission of Electrons in the Selective and Normal Photoelectric Effects.* **A. L. Hughes.** (Phys. Rev. 10. pp. 490–494, Nov., 1917.)—The selective and photoelectric effects have been investigated almost entirely through a study of the variation in the total number of electrons emitted from suitable metallic surfaces, with the wave-length of the light used. It is therefore desirable to attack the problem in another way in the hope that some evidence as to the difference between the two effects may be obtained. The author attempted this in an investigation of the distribution of electrons emitted from a surface of sodium-potassium alloy [see Abs. 369 (1916)]. The results showed that the distribution was not identical for the selective and for the normal photo-electrons, but did not settle whether the difference was one in the "direction-distribution" or in the "velocity-distribution" of the photo-electrons in the two effects. The experiments now described show that there is a definite difference in the "direction-distribution" of the photo-electrons, and suggest a systematic examination of the "velocity-distribution" and the "direction-distribution" of photo-electrons emitted from surfaces illuminated by polarised light. It is proposed to carry out the experiments on metals which show the selective effect, such as Na-K alloy, and on metals such as mercury, which show only the normal effect. By using liquid surfaces, it can be made much more certain that the plane of polarisation of the light has a definite meaning with respect to the plane of the surface.

A. E. G.

95. *Emission of Electrons by a Metal when Bombarded by Positive Ions.* **W. L. Cheney.** (Phys. Rev. 10. pp. 335–347, Oct., 1917.)—The work

described in this paper was undertaken to determine how the number of negative electrons emitted by a metal when bombarded by positive ions in a vacuum depends on the number, velocity, and the nature of the positive ions. The researches of Townsend, Thomson, Campbell, McLennan, and others, are reviewed, and the results compared with those of the author and with theory. A. B. W.

96. *Application of Thermionic Currents to the Study of Ionisation by Collision.* **F. Horton.** (Phil. Mag. 34. pp. 461–477, Dec., 1917.)—The theory of ionisation by collision has been verified experimentally for several gases by Townsend and others. The method used consisted in measuring the currents between two parallel plate electrodes when the ions are set free initially at the surface of the negative electrode by the action of ultra-violet light. Townsend has shown theoretically that under these conditions if n_0 ions are set free at the surface of the negative plate, and if, on the average, each negative ion creates α new pairs of ions, and each positive ion creates β new pairs of ions by collisions in moving through 1 cm. of gas, the number of ions reaching the positive plate is given by $n = n_0(\alpha - \beta)\varepsilon^{(\alpha-\beta)d}/\alpha - \beta\varepsilon^{(\alpha-\beta)d}$, d being the distance between the parallel plate electrodes, and large compared with the mean free path of the ions.

The experiments described in the present paper were the commencement of an investigation of the ionising properties of the ions emitted by glowing solids. The method of studying the ionisation by collision is, in principle, that of Townsend, but a glowing solid (an electrically heated, lime-coated, Pt-wire) is used as the initial source of negative ions, instead of a zinc plate illuminated by ultra-violet light. From the tabulated results and curves included in the paper it is shown that the results are in good agreement with those of Townsend. The ionisation in these experiments takes place at temperatures up to 100° C. (the gas temperature-filament being at 1000° C.) higher than the temperature in Townsend's experiments, and this general agreement of the results is direct evidence that, in the case of negative ions, the power of ionising by collisions in a gas of given density is independent of the temperature within these limits. A. B. W.

97. *Spark-lengths in Gases and Vapours.* **R. Wright.** (Chem. Soc., J., Trans. 111. pp. 643–649, July, 1917.)—The comparative study of spark-lengths in different gases and vapours is rendered difficult by the circumstance that what is ordinary temperature and pressure for gases may be extreme conditions for vapours. The author first attempted to compare vapours at their boiling-points, but he was troubled with condensation on the electrodes. He therefore decided to keep the two spark-gaps of air and the substance under test, at the same temperature so as to have the same number of molecules per unit volume ; when the spark is produced in a closed vessel, heating the gas has no influence on the spark-length, and the volts required are independent of the temperature ; in an open vessel, in which the gas can expand, rise of temperature (or diminution of the gas pressure) increases the spark-length corresponding to a certain p.d. A gap of 20 mm. at 100° C. corresponded with a gap of 15 mm. at 18°, and a gap of 20 mm. at 188° with one of 5 mm. at 18°. The electrodes of his standard air-gap were brass spheres of 5 mm. adjustably mounted in a vertical glass tube 15 mm. in diam., surrounded by a vapour-jacket ; the other tube was similarly arranged, and the two tubes were electrically in parallel with an induction coil. By the aid of a third gap the potential was varied ; this gap, closed to start with, being gradually

widened during an experiment. The results differed frequently by 10 % and more, and the spark-length corresponding to an air-gap of 20 mm. was not $\frac{2}{3}$ of that with a 30-mm. air-gap, as it should have been with parallel curves of spark-length and potential. The curves intersected in fact sometimes; thus carbon dioxide proved a better insulator than air at low temperatures, but a better conductor at high potentials. On the whole, however, for series of chemically comparable substances an increase in molecular weight is accompanied by an *in*crease in insulating power (*de*crease of spark-length). Thus methane CH_4, methyl chloride, $CH_3 . Cl$, methylene chloride, $CH_2 . Cl_2$, chloroform CH, Cl_3, carbon tetrachloride CCl_4, give at 100° with an air-gap of 30 mm., spark-lengths of 29, 24, 9, 5, 1·5 mm. Other homologous compounds and also CO_2, SO_2, CS_2, H_2S showed similar relations. H. B.

98. *The Pressure-increase in the Corona.* **E. H. Warner.** (Phys. Rev. 10. pp. 483–489, Nov., 1917.)—It has been reported by Farwell and Kunz that at the instant the corona appears about an axial wire in a cylindrical tube, the pressure of the gas in the tube suddenly increases [Abs. 1065 (1916)]. It has always been stated that this pressure increase could not be due to heat, because of the instantaneous character of its appearance, and because of the rapidity with which it disappears so soon as the potential is removed from the wire. Since the only theories which have been advanced to explain the corona assume it to be an ionisation phenomenon, it seemed reasonable to suppose that this pressure-increase was due to the increase in the number of gas particles in the tube, and so it was called ionisation pressure. Experiments have been performed which show that this pressure increase is exactly proportional to the corona current, with the wire positive when dry air, hydrogen, carbon dioxide, oxygen, and ammonia are the gases in the tube. Since the publication of these data Arnold has contended that the pressure increase could be completely accounted for as the result of Joulean heat, and that the assumption that it is due to ionisation is untenable. To support this contention Arnold performed experiments "by electrically heating the central wire in apparatus similar to Farwell's and observing the pressure increase." With such an apparatus Arnold attempted to show (1) that an increase in pressure due to heat appears suddenly, (2) that for a given power consumed in the tube the increases of pressure due to heat are of about "the same magnitude as those observed" in the corona. In order to show clearly that the pressure increase is not due to heat, a series of comparative experiments were performed with the pressure-increase caused, first by producing the corona glow on the wire, and secondly by heating the central wire. The experimental results show: (1) that the increase in pressure due to corona appears and disappears much more rapidly than when due simply to heat. (2) That the heat in the corona discharge is not a prominent factor until many seconds after the corona appears. (3) That in equal-energy experiments the increase in pressure due to corona differs from the increase in pressure due to heat by about 50 %. (4) That at the instant the corona appears the gas in the tube at a small distance from the wire is cooled. (5) That the theory advanced by Kunz is verified in one more field, namely, in the relation between current and pressure for constant voltage.

These results, together with conclusions drawn from simple calculations, lead to the belief that the pressure increase in the corona discharge is not due to Joulean heat. With the recent knowledge of the distortion of the field in the corona tube it seems very possible that the increase in pressure is due to ionisation. A. E. G.

99. *Experimental Investigations on the Diffraction of Electromagnetic Wa* **M. Sjöström.** (Upsala Univ. Arsskrift, No. 1. 1916. Elektrot. u. M chinenbau, 35. p. 547, Nov. 11, 1917. Abstract.)—Describes experiments w electric waves of 40 cm. on the diffraction at a straight edge. Maxwe theory was confirmed. E. H.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

100. *Influence of Pressure upon the Electric Conductivity of Pure Me according to Grüneisen's Theory.* **II. B. Beckman.** (Phys. Zeits. 18. pp. 509, Nov. 1, 1917.)—E. Grüneisen [see Abs. 1047 (1913)] has deduced following expression for the change of electrical conductivity with pr sure :—

$$\alpha = \frac{1}{\sigma}\left(\frac{d\sigma}{\partial p}\right)_T = -\frac{1}{u}\left(\frac{\partial u}{\partial p}\right)_s + \frac{1}{N}\left(\frac{\partial N}{\partial p}\right)_s - K_s + \frac{1}{C_p}\frac{\partial v}{\partial T}\left(1 + \alpha_T T\right),$$

where σ is the electrical conductivity, α the pressure coefficient, u the veloc of the electrons, N the electronic concentration, K_s the adiabatic compr sibility, C_p the atomic heat, $1/v \cdot \partial v/\partial$ Tthe coefficient of voluminar expansi w the resistance, $\alpha_T = 1/w \cdot \partial w/\partial T$ the temperature coefficient of resista at absolute temperature T, and v the atomic volume. The first ter $1/u \cdot \partial u/\partial p$, which is unknown has been neglected by Grüneisen, and t second term has been taken from the observations of E. Wagner. In previous paper the author tested the relation for 12 different metals a found that, with the exception of Au, Ag, Al, and Cu, the expression m only be regarded as a first approximation. The author now gives the expe mental data Tl, Ta, Mo, and W. Five tables of results are included. T pressure coefficients are found to be lower than those expected on Gr neisen's theory. The differences between the theoretical and observ values are not removed by omitting the second term $1/N \cdot \partial N/\partial p$ from t expression. H. H. H

101. *Electrical Conductivity of Sputtered Films.* **R. W. King.** (Phy Rev. 10. pp. 291–300, Sept., 1917.)—The specific resistance of the ve thinnest metal films is abnormally high. Two theories have been advanc to explain this fact : one, by J. J. Thomson, depends upon a shortening the mean free path of the conducting electrons by the surface of the fil the other, by Swann [Abs. 100 (1915)], depends upon an assumed granu structure of the film and a consequent opposition offered to the motion of t electrons by the gaps between the grains. Swann has raised one objecti to Thomson's theory ; another has developed as the result of the autho work. Reasons are given for rejecting Thomson's and Swann's theories. relation connecting conductivity and thickness is deduced from the supp sition of a more or less random arrangement of groups of atoms. Th relation seems to fit observations upon films of Pt, Au, and Ag in a ve satisfactory manner. It has been found that the thinnest films of Au and A show a granular structure when examined with a " dark-field " microscop and that thicker films of these metals appear quite uniform. No structu has been observed in Pt films, but this is probably due to the limitations the microscope. It has been found that in order just to begin to condu Pt films must be between 1·5 $\mu\mu$ and 3 $\mu\mu$ thick, Au and Ag films betwe 6 $\mu\mu$ and 8 $\mu\mu$ thick. As it seems doubtful if particles of the sizes necessitat by these thicknesses can be detached from the kathode by the bombardme

their formation is probably due to the condensation of atoms of the metals. This supposition is further supported by the similarity between the author's results and those of Weber and Oosterhuis obtained on films produced by condensation. It is pointed out that the recorded variations of n and k with thickness appear to present no obstacles to the acceptance of the present theory. I. W.

102. *Thermal and Electrical Conductivities of Carbon Steels.* **T. Simidu.** (Tôhoku Univ., Sci. Reports, 6. pp. 111–122, Sept., 1917. Sixth Report from Alloys Research Inst.)—The author has measured the specific resistance and thermal conductivity of 12 samples of Krupp steels with varying carbon content ranging from 0·14 to 1·50 %. The specimens were cylindrical, 20 cm. long and 5 mm. diam. The method employed was that of Kohlrausch, in which the ends of the rod are kept at a constant temperature and an electric current i is passed along it. When the steady state is set up the temperature distribution is parabolic provided there is no lateral loss of heat. The specific resistance σ is then $qV/i \,.\, 2l$, where q = cross-sectional area of rod, V = p.d. between the ends and $2l$ = length of rod. The thermal conductivity, λ, is $V^2/8\sigma U$, where U is the mean of the temperature-differences between the middle and ends of the rod. To prevent lateral loss of heat the rod was placed centrally in a cylindrical guard tube and the temperature distribution along this guard tube was adjusted to be the same as that along the rod. Observations were taken for the specimens (1) as forged, (2) annealed at 900° C. for one hour in a vacuum, (3) quenched in oil from the same temperature. The results are given in a series of tables and curves. If the resistance be considered as a linear function of the carbon percentage (C) and the sum of the atomic percentages of Mn and Si (b) the following relations were obtained from the observations by the method of least squares :—

$$\left.\begin{aligned} \sigma_{\text{forged}} &= 1{\cdot}309 + 0{\cdot}613b + 0{\cdot}358\,\text{C} \\ \sigma_{\text{annealed}} &= 1{\cdot}416 + 0{\cdot}422b + 0{\cdot}367\,\text{C} \\ \sigma_{\text{quenched}} &= 1{\cdot}218 + 0{\cdot}720b + 0{\cdot}602\,\text{C} \end{aligned}\right\} \text{at } 30^\circ\text{ C.}$$

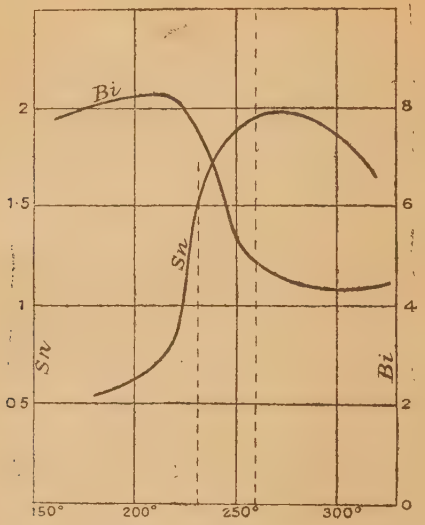
The observed values agree closely with those calculated from the equations, the greatest deviations being shown in the case of the quenched specimens, probably due to accidental incomplete quenching. Benedicks has proposed the relation $\sigma = 7{\cdot}6 + 26{\cdot}8\Sigma\text{C}$ for the specific resistance of annealed steels. ΣC is the percentage of dissolved carbon together with the sum of the carbon values of all the other dissolved elements. Benedicks' observed results for annealed steels treated in the same way as the author's show large deviations between observed and calculated values. The observations of le Chatelier and Hopkinson, however, practically agree with the author's view. The thermal conductivity data are represented by—

$$\left.\begin{aligned} \lambda_{\text{forged}} &= 0{\cdot}1335 - 0{\cdot}0323b - 0{\cdot}0194\,\text{C} \\ \lambda_{\text{annealed}} &= 0{\cdot}1217 - 0{\cdot}0199b - 0{\cdot}0185\,\text{C} \\ \lambda_{\text{quenched}} &= 0{\cdot}1284 - 0{\cdot}0310b - 0{\cdot}0308\,\text{C} \end{aligned}\right\} \begin{array}{c}\text{at } 30^\circ\text{ C} \\ \text{in} \\ \text{gm. cals./deg. cm. sec.}\end{array}$$

the experimental and calculated values agreeing satisfactorily. The product $\lambda\sigma$ is fairly constant, the mean value being $7{\cdot}75 \times 10^{-10}$ in e.m. units. L. L.

103. *Experimental Test of the Wiedemann-Franz Ratio through a Change of State.* **E. F. Northrup** and **F. R. Pratt.** (Frank. Inst., J. 184. pp. 675–688, Nov., 1917.)—Northrup and Suydam have previously determined the resis-

tivity of the metals Bi and Sn as they pass through their melting-pc
[Abs. 1046 (1913)]. In the case of Sn the ratio of the resistivity just
fusion to that before is 2·154, whereas the resistivity of Bi diminishes
fusion, the ratio being 0·47. In the present paper the authors describe



apparatus for measuring the thermal conductivities of metals as they pa
through their melting-points. The metal is contained in a hollow alberer
stone cylinder and pressed between two steel cylinders. The upper ste
cylinder is heated electrically and the end of the lower cylinder steam-heate
The whole is lagged and the temperature gradient between two fixed poin
in the metal is compared with that between two points in the lower ste
cylinder. The metals Bi and Sn were investigated and the results are repr
sented graphically in the Fig., where the thermal resistance relative to steel
plotted against the temperature. The author concludes that the therm
resistance characteristics for both Sn and Bi when they pass from the sol
to the molten state are substantially the same as the electric resistan
characteristics, and the Wiedemann-Franz law holds to a first approximatio
when these metals pass through the change of state. L. I

104. *Electric Conductivity of Mica.* **E. Branly.** (Comptes Rendus, 16
pp. 450–455, Oct. 8, 1917.)—Describes experiments on the conductivity of ver
thin discs of mica. These were introduced between two metal electrode
whose surfaces were optically plane-polished, and they were arranged in
special apparatus which allowed the pressure between them to be easil
adjusted and measured. With mica discs of thickness about 0·003 mm. i
was found that the resistance could be brought in a short time to a negligibl
value, although the e.m.f. initially applied to the two electrodes was less tha
0·004 volt and the pressure between them did not reach 1 cm. of mercury
The conducting power, when once established, could be maintained fo
several hours without change. With mica of thickness 0·004 mm. or more
similar results were not attained, but the action under the influence of electri
discharges at some distance was the same as with the thinner mica, both acting

like ordinary radio-detectors. Examination of the mica with polarised light revealed tiny holes, and it is possible that these have something to do with the conductivity of the very thin leaves of mica used. A. W.

105. *Electrometallic Effects exerted through Thin Sheets of Mica.* **E. Branly.** (Comptes Rendus, 165. pp. 524–529, Oct. 22, 1917.)—Continuing his experiments on thin sheets of mica [see preceding Abs.] the author has now found decided rectification effects when the polished metal plates, between which the mica is held, consist of two different metals such as Ag and Pt. With two Ag plates the current through the mica was the same in either direction, but with the Ag-Pt combination a much greater galvanometer deflection was always obtained with the Ag positive than when the Ag was negative. Palladium gave similar results, but with Ag and Co no marked unipolarity was observed. The mica used in the experiments was about 0·005 mm. thick. A. W.

106. *Thermoelectric Effect in Mercury due to Asymmetric Heating.* **C. Benedicks.** (Comptes Rendus, 165. pp. 426–428, Oct. 1, 1917.)—The new thermoelectric phenomenon observed by the author when a metal is heated asymmetrically [Abs. 675, 1369 (1917)] can be regarded as the reverse of the Thomson-effect. The new effect has been observed in a large number of metals and alloys and the direction of the current is in accordance with that required by the known sign of the Thomson-effect. Objection has been raised by some as to the actual existence of the Thomson-effect, it being regarded as a spurious Peltier-effect due to the heterogeneous structure of the material. The existence of the Thomson-effect in mercury overthrows this objection. The new effect has now been observed by the author in mercury and the direction of the current conforms with that required by theory. L. L.

107. *Electrical Properties of Bismuth in and out of the Magnetic Field.* **G. Borelius** and **A. E. Lindh.** (Ann. d. Physik, 53. 10. pp. 97–137, Oct. 26, 1917.)—The authors have measured the resistance at room temperature, and the Peltier coefficient against copper, of bismuth both in and out of the magnetic field. Borelius has recently described an apparatus [Abs. 807 (1917)] by which the Peltier coefficient can be determined and this type was employed in the present investigation. One of the objects of the research was to correlate the various quantities measured with reference to the crystal structure and for this purpose small parallelopipeds were cut from a Bi casting with their edges respectively parallel, perpendicular, and at 45° to the principal cleavage plane. The ordinary theory as given in Voigt's "Krystallphysik" is employed and there is good agreement between the observed and calculated values for the resistance in the various directions and the corresponding increments in the magnetic field. Such verification of the resistance law has previously been obtained by van Everdingen. With regard to the data obtained for the thermoelectric force and the Peltier coefficient it would appear that the principal thermoelectric axis is inclined at about 25° to the crystallographic axis. This is contrary to the view of F. L. Perrot, whose data are consistent with the coincidence of the thermoelectric axis and the crystallographic axis. The effect of the magnetic field on the Peltier coefficient against copper is to make it more negative, and the change is proportional to the square of the field strength. The authors have been able to observe in Bi a transverse Peltier-effect which was predicted by Kelvin in his thermoelectric theory for certain crystals. This effect was proportional to the current passing and amounted to a temperature-difference of 0·267 deg. per ampere in a crystal

plate cut at 45° to the axis, the unequally heated faces being 1·55 mm. a
The electrical after-effect was also measured in the various crystal speci
and the data obtained support the theory advanced by Heurlinger [Abs.
(1916)]. The after-effect did not appear, however, in a plate prepared
trolytically. This may be accounted for either by the very fine crystal stru
of the plate or by the fact that such a plate may be isotropic, or the prin
thermoelectric axis may be perpendicular to the plane of the plate.

ALTERNATING CURRENTS AND MAGNETISM.

108. *Experimental Evidence for the Parson Magneton.* **L. O. Grond**
(Phys. Rev. 10. pp. 586–588, Nov., 1917. Abstract of paper read before the
Phys. Soc., Dec., 1916.)—The author explains how, from the point of vie
the Parson magneton, the thermoelectric force of a copper-iron circuit sh
be diminished in a weak magnetic field and increased in stronger fields.
agrees with experimental evidence. A rough calculation of the change in
thermal e.m.f. produced by the magnetic field is made, and is of the s
order as that observed. Existing data for Ni and Co also support the auth
view. The explanation would involve as a corollary that the copper wo
become magnetised, due to the orientation of the free magnetons. In a fi
of 9000 gauss the intensity of magnetisation of copper would be approximat
270. This may be masked by diamagnetism. L.

109. *Magnetic Hysteresis and van der Waals' Equation.* **E[va] Bruin**
(Phil. Mag. 34. pp. 380–382, Oct., 1917.)—J. R. Ashworth [Abs. 379 (191
gave for a ferromagnetic substance the equation $(H + a'I^2)(1/I - 1/I_0) = R$
which he considered as an analogy to van der Waals' equation, and suppos
the Curie temperature to be the same as the critical temperature determin
by this equation. The authoress points out that above the Curie temperatu
the magnetisation is always zero at an exterior field zero, so that remane
magnetism cannot exist in this state, and shows, in consequence, that th
Curie temperature is lower than the critical temperature as determined b
the equation, and which is the one analogous to the critical temperature of
fluid. She also observes that Curie [Phys. Soc., Abs. 593 (1895)] lays stress o
the fact that the analogy cannot be pushed too far, because the conformit
between $\rho = f(P)$ and $I = f(H)$ at constant temperature is doubtful, and th
conformity must exist if Ashworth's equation be valid.

J. R. Ashworth, in an appended note, admits the validity of the criticism
as regards the distinction between the Curie temperature and the critica
temperature of his equation, and points out that he has dealt with it in a
recent paper [Abs. 531 (1917)]. He observes that the resemblance between
the curves $I = f(T)$ and $\rho = f(T)$ is more obvious than that between $I = \phi(H)$
and $\rho = \phi(P)$, as Curie pointed out, and the fluid analogy must be followed
with caution, *e.g.* I is a vector and ρ is not. The hypothesis of the intrinsic
field needs careful scrutiny, but he suggests that one of Curie's doubts may
be allayed if the interpretation of magnetic hysteresis according to the fluid
analogy is correct. Thus Curie states [*loc. cit.*] that the curve of stable mag-
netisation has no fluid analogy, whereas Ashworth has shown, in the later
paper referred to, that this curve, which he called a hysteretic isothermal,
naturally finds its place according to theory side by side with the two branches
of the hysteretic loop, and from this point of view is analogous to the sudden
passage of a saturated vapour to the liquid state. G. W. DE T.

110. *Magnetisation of Iron Powder.* **K. Honda.** (Tôhoku Univ., Sci. Reports, 6. pp. 139–147, Sept., 1917. Eighth report from Alloys Research Inst.)—It is well known that the specific magnetisation of a ferromagnetic powder is much less than that of the same material in compact mass for equal values of the magnetising field. In addition, the specific magnetisation increases with the density of the powder, and in a sufficiently strong field becomes independent of the density and has the same value as the compact mass. The difference is due to the demagnetising force called into play on account of the distribution of magnetism on the particles of the powder. A similar behaviour is to be expected in those alloys which consist of an aggregate of different constituents forming a heterogeneous system. The author has carried out a series of experiments to obtain a general idea of the magnitude of this demagnetising force. The specific magnetisation (σ) was determined in fields up to 1000 gauss. The powder employed consisted of ordinary reduced iron. For low densities (up to 2) it was mixed with fine sand ; for densities 2–4, compressed in a glass tube, and for higher densities hydraulic pressure was employed. The same powder was fused in a non-oxidisable atmosphere in order to obtain a cylinder of compact material. The results are represented in a series of curves. If fields H_1 and H_2 are required to produce the same value of σ for the compact mass and powder respectively, the demagnetising factor N is $(H_1 - H_2)/\sigma$. N increases rapidly with the magnetising field, and decreases logarithmically with the density. The largest value of N is about one-half that of a massive sphere. For purposes of comparison similar curves were obtained for a number of steel balls. With these the demagnetising factor gradually decreases from $4\pi/3$ to 1·08 for a contiguous column. This is of the same order of magnitude as that for the powder.

The author concludes that if the magnetisation of a substance in the form of a powder is to be compared with that of iron or other known substances in compact mass, then the magnetisations should be measured near the saturation value, namely, in fields of the order 10^4 gauss ; for all magnetisation curves would attain the same asymptotic value in such fields. L. L.

111. *Magnetic Properties of Manganese and some Special Manganese Steels.* **R. Hadfield, C. Chéneveau,** and **C. Géneau.** (Roy. Soc., Proc. 94. pp. 65–87, Dec. 1, 1917.)—Measurements of the mass susceptibility (χ) for Mn and some Mn-steels have been made with the magnetic balance of Curie and Chéneveau [see Abs. 374 (1904)] with the object of studying the influence of chemical constitution on the magnitude of χ. The specimens were contained in glass tubes of special composition which gave no appreciable deflection when the balance was at its greatest sensibility. The range of fields was from 320 to 1600 gauss, and the balance was standardised with anhydrous cobalt sulphate for which $\chi = +58 \times 10^{-6}$ at 20° C. Both powdered and cast Mn were found to be paramagnetic, and the value for the susceptibility at 18° was $+11 \times 10^{-6}$. The ferromagnetic properties which Mn possesses after being melted or deposited by electrolysis are undoubtedly due to occluded hydrogen. The alloys examined were found to be paramagnetic, χ varying from $+17 \times 10^{-6}$ to $+259 \times 10^{-6}$. The quantity of Mn present in the steels examined has little influence upon the value of χ, but for constant Mn-content the susceptibility increases as the C content diminishes. In Ni-Mn steels containing approximately the same C/Mn ratio the susceptibility increases with the proportion of Ni. The addition of Cu or Cr to a Mn-Ni steel raises the susceptibility, and there is a large increase when tungsten is added. The lower the tem-

perature from which a steel is cooled, the greater the increase in susceptibility. The addition of 6 % Si to a Mn steel where the C|Mn ratio is about 0·01 makes the steel much more ferromagnetic. A secular change in the magnetic properties of this steel has also been observed, the specific magnetism increasing in a period of several years from the order of 4 or 5 % of that of pure iron up to nearly 50 %. L. L.

112. *Resistance and Magnetisation.* **C. W. Heaps.** (Phys. Rev. 10. pp. 366–376, Oct., 1917.)—In the first part of this paper the author extends the electron theory of metals to cover the case of change in electric resistance when the material is subjected to a magnetic field applied either parallel or transverse to the direction of flow of the current. If δR is the change in the electrical resistance R, and $\delta\lambda$ the change in the mean free path λ_0 of the electron under the influence of a longitudinal magnetic field, it is shown that $\delta R/R = -\delta\lambda/\lambda_0$. For a field (H) applied transversely, if dR and $d\lambda$ are the corresponding changes in resistance and mean free path,

$$dR/R = H^2e^2/m^2 \cdot \lambda_0^2/V^2 - d\lambda/\lambda_0 ;$$

e/m being the ratio of the change to the mass of the electron, and V the velocity of agitation of the electrons. If the material is magnetically isotropic $\delta\lambda/\lambda_0 = d\lambda/\lambda_0$ and $dR/R - \delta R/R = 9H^2\sigma^2/4n^2e^2$; σ being the specific electric conductivity and n the number of electrons per unit volume. According to this theory the increase by the transverse field is much greater than that by the longitudinal field. It is evident that the crystal structure of the specimen plays an important part in the magnitude of the resistance-change, and for this purpose the author has investigated the change in graphite under varying forms. He finds the effect of the magnetic field on compressed graphite powder to be greater when the powder is coarse than when fine. This implies that in a substance composed of large crystals the effect is greater than when the crystals are small. This probably explains the fact that Bi when in the form of fine powder produced by the chemical reduction of a Bi salt, has its resistance but little affected by the magnetic field. It is possible by making up specimens in the proper manner to compare longitudinal and transverse effects of the field without any trouble arising from crystalline structure. For this purpose a thin section was cut from a cast Cd cylinder, normal to its axis, and hammered out into a thin plate. Parallel cuts were made in this plate so as to form a grid. The change in resistance of this grid in a transverse field of 7550 gauss was the same whether the field was parallel or perpendicular to its surface. It was thus assumed magnetically isotropic. The magnetic field could be rotated in the plane of the grid and the value of $dR/R - \delta R/R$ determined. For $H = 7550$ gauss this difference was 9×10^{-6}, a value agreeing substantially with that previously obtained by the author for Cd wire [Abs. 574 (1912)]. Assuming that wires of other materials can be treated as magnetically isotropic the calculated values of n and the free period $T(=\lambda_0/\nu)$ of the electrons for a number of materials are :—

	n.	T.		n.	T.
Te.....	$5·0 \times 10^{20}$	$5·1 \times 10^{-18}$	Zn	$2·2 \times 10^{22}$	0·4
Bi.....	$11·8 \times 10^{18}$	39·2	Au	$18·8 \times 10^{22}$	0·12
PbS	$2·9 \times 10^{19}$	0·8	Graphite (large natural crystals)	$1·74 \times 10^{18}$	11·4
Cd.....	$1·2 \times 10^{22}$	0·59			

L. L.

113. *Reversal of the Hall-effect in Alloys.* **A. W. Smith.** (Phys. Rev. 10. pp. 358–365, Oct., 1917.)—The reversal of the Hall-effect in Bi-Sn alloys for a certain magnetic field strength was observed by v. Ettingshausen and Nernst. They suggested that it might be accounted for by the longitudinal potential effect called into play by reason of the co-existence of the Ettingshausen-effect with the Hall-effect. In the present paper the author shows that the magnitude of the longitudinal effect is totally insufficient to account for the reversal in sign of the Hall-effect. He has observed in addition the reversal of the Hall-effect in Bi-Sn alloys for alternating currents (frequency 60) and here it would be imagined that the thermal effects on which v. Ettingshausen and Nernst based their explanation would not have sufficient time to become effective. The author has also observed the reversal of the Hall-effect in the case of Bi-Pb alloys, and here again the longitudinal potential effect is wholly insufficient to account for the change in sign. Becquerel has suggested that these curves for Hall e.m.f. and field strength which rise to a maximum, diminish in magnitude, and finally reverse sign may be split up into two : (1) a straight line passing through the origin ; and (2) a curve which rises to a fixed value after which it is parallel to the field axis : the ordinates of these curves are of opposite sign. The choice of these resolutes is of course arbitrary, but the slope of the straight line so obtained is 40 times greater than the possible correction arising from the longitudinal potential effect.

L. L.

114. *Measurement of Horizontal Intensity of Earth's Magnetism.* **C. Dieterici.** (Phys. Zeits. 18. pp. 402–404, Sept. 1, 1917.)—Comparisons are given of several determinations of H, with detailed dimensions of the apparatus used. C. P. B.

115. *Influence of Lunar Declination on Magnetic Declination at Zi-ka-Wei.* **S. Chapman.** (Terrest. Magn. 22. pp. 121–124, Sept., 1917.)—Calculations have been made to see how far theory may account for the interesting results obtained by J. de Moidrey's investigation of the influence of lunar declination on the lunar-diurnal variation of magnetic declination at Zi-ka-Wei. For this tables are given showing Fourier coefficients of the first two harmonic components of the variations, (*a*) for the whole saros 1890–1908 ; (*b*) for the days when the moon was at or near its nodes ; (*c*), (*d*), for the epochs of the maximum north and south declination. [Abs. 165 (1917).] C. P. B.

116. *Magnetic Pulsations at Zi-ka-Wei and Lu-Kia-Pang.* **J. de Moidrey.** (Terrest. Magn. 22. pp. 113–120, Sept., 1917.)—Defining pulsations as oscillations of short period with sensibly constant amplitude, an account is given of their variation in the results during the three periods 1896–1908, 1908–1912, and 1913–1916. Curves are given illustrating the variations of these pulsations as presented in several classes, diurnal, annual, seasonal, rapid and slow, with a short discursion of the characteristics of each type. C. P. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY

117. *Variable Atomic Weights.* **H. S. Shelton.** (Chem. News, pp. 259–261, Nov. 30, 1917.)—The author raises objections to Soddy's th of isotopes—particularly with regard to its applications to the stud geological time. A. H

118. *Aluminium-Zinc Alloys.* **O. Bauer** and **O. Vogel.** (Internat. f. Metall. 8. 3. pp. 101–178, June, 1916. Material-Prufungsamt, Mit pp. 146–198, 1916. Rev. de Mét. 14E. pp. 148–151, July, Aug., 19 The experiments were made with an Al containing 0·23 % Fe and 0·1 Si, and a pure zinc (from Kahlbaum), about 200 gm. being fused in bi porcelain crucibles; special precautions to prevent oxidation were taken. Thermo-couples of Pt-Rh and (below 350°) of silver-consta were used. The solidification point of zinc was found correct at 419°, of Al, 657°, was probably 3 deg. too low. Critically reviewing the literat the authors confirm, on the whole, the equilibrium diagram of Rosenhain Archbutt [Abs. 1611 (1911)], but they limit, as to their extension into region of higher Al-percentage, the two horizontal lines of heat evolution 443° and 256°) and also the eutectic line at 380°. While 40 % of Zn soluble in Al, the solubility of Al in Zn α-phase is only 0·75 % at 380°, the variation of this solubility with temperature could not be ascertain The β-phase is the compound Al_2Zn_3; the γ-phase a solid solution of in Al containing 75 % Al maximum; between 0 and 256° the $(\gamma + \beta)$ decomposed into $(\alpha + \gamma)$. Microscopic examination (plates reproduc agrees with the conclusions arrived at. The alloys with from 7 to 10 % were tested for tensile strength, elongation and hardness, the latter by Martens ball test; the resulting figures indicate the number of kg. requir to force the ball into the metal to a depth of 0·05 mm. The mechanical te were also applied to a commercial sheet metal (99 % Al, Fe, and Si, 0·03 C and traces of Zn, Ni, C); the specimens were taken: (*a*) as left after dete mining the cooling curves; (*b*) reheated for 72 hrs. to 350° and then f 48 hrs. to 230°; or reheated to 420° and then to 230°, when containing mo than 21·65 % Al; (*c*) quenched. The density and specific volumes we also determined as previously by Shepherd. In order to distingui rapidly between commercial Al containing Zn and Al free from Zn th authors immerse the specimens in 5 % NaOH; in the presence of Zn th γ-phase turns black (this black film cannot be wiped off, as it could b if copper were present), whilst the Al free of Zn remains white. Final corrosion tests were made in water (i) from the water main, (ii) distille (iii) North Sea water. Cold-drawn and cold-rolled Al was badly attacked i (i) developing boils and peeling; Zn-Al was also attacked, but did not sho boils; in (ii) Zn-Al was much more corroded than Al; in (iii) there wa more general white excrescence on the surface than in the other cases, bu the boils were not so bad as in (i); with pure Al the alloys become deepl pitted, but did not show boils. Exposed to the atmosphere the metal an alloys turned white or grey, but did not corrode. The metal annealed a 420° stood the water tests better than the other metals. By immersing th metal for 2 or 4 hours in a litre of water containing 25 gm. each of th carbonates of potassium and sodium and 10 gm. of potassium dichromat at 90 or 95°, washing and drying, the authors coated the metal and allo with a greyish layer; so protected the Al and alloys are much mor

resistant to the action of water, but the treatment does not prevent corrosion by hydrochloric acid. The treatment causes only a very slight loss of metal and does not affect the strength of the material. H. B.

119. *Cooling Curves of Quenched Metals.* **Garvin** and **P. Portevin.** (Rev. de Mét. 14. pp. 604–606, Sept.–Oct., 1917.)—A general account of experiments for the study of the cooling curves of similar cylindrical specimens, of diams. ranging from 8 up to 20 mm., and lengths equal to 3 times the diam. The apparatus consists of a moving-coil galvanometer and a couple of Pt/Pt-Rh, wires 0·1 mm. thick, in a quartz sheath of diam. 0·6 mm.; the total electric resistance is about 340 ohms. A hole 2·5 mm. in diam. is drilled into the specimens, and the couple lowered into the hole, on the bottom of which it rests by its own weight; thus good contact is ensured to which Benedicks, the authors suggest, did not pay sufficient attention. The specimen is held fixed, the furnace and the quenching appliance (spray of 0·1 litre of water per sec.) being moved into position. Experiments have been made with Ag, Al, Ni, and a 30 % nickel-steel. The photographic curves obtained should be quite concordant, but were satisfactory only when the specimens did not cool quickly. The curves cannot be represented by a general formula such as McCance [Abs. 1757 (1914)] suggested which would hold only for specimens of the same metal, not differing much in diam., or for metals of similar physical properties. H. B.

120. *Cementation of Iron.* **S. A. Fechtchenko-Tchopovsky.** (Russ. Metall. Soc., J. 1. pp. 480–510, 1915. Rev. de Mét. 14E. pp. 90–95, March–April, 1917.)—The author has continued the work described in Abs. 1300 (1916). To determine the influence of nitrogen, cementation was carried out in wood-charcoal containing varying proportions of potassium ferrocyanide. After cementation the carbon and nitrogen contents of the case were determined. At high temperatures (above 850° C.) the nitrogen content of the case is insignificant, but increases as the temperature is lowered. At temperatures below 750° C. the nitrogen absorbed increases with the nitrogen content of the cement; it also increases with the time, but very irregularly, the absorption being rapid in the early stages but very slow after the second hour. Nitrogen increases the hardness of the case, 0·1 % raising the Brinell hardness by 17 kg./mm.^{2}

In cementation with barium carbonate-charcoal mixtures, the cementing power diminishes as the content of BaO increases. Small quantities of this material render the case irregular, while larger quantities destroy the cementing power. The total depth of penetration is independent of the quantity of carbonising material, but the thickness of the hypereutectic layer diminishes as the quantity of cement per unit area of object to be carbonised is decreased. At 1000° C. no useful object is attained in having more than 1·5 cm.^{3} of carbonising mixture per 1 cm.^{2} area of object to be cased. Under similar conditions the hypereutectic layer on an object cased in an electric furnace is thicker than the layer obtained in a gas furnace. This is ascribed to the diffusion of the furnace gases into the carbonising box. For the most rapid, energetic and regular carbonising the author advises the use of a mixture consisting of 70 % wood-charcoal and 30 % anhydrous sodium carbonate. F. C. A. H. L.

121. *Martensite, Troostite, Sorbite.* **P. Dejean.** (Comptes Rendus, 165. pp. 429–431, Oct. 1, 1917.)—The author accepts le Chatelier's definition of martensite and proposes to use the other terms in the following senses :—

Troostite is an ultramicroscopic aggregate of iron carbide and iron attacked by micrographic reagents, and obtained by tempering a steel previously heated to a temperature at least equal to that of the critical point with an energy insufficient for producing pure martensite. It generally dark roundish spots, sometimes bordered with needles, on a bright ground martensite or austenite, and might especially be called *troostite de* formed at the point A. Sorbite is chemically and physically nearly identical with the troostite just defined, but is obtained by thermal treatment below critical point Ac_1 of a steel previously tempered; it might be called *de revenu* and forms generally the ground mass itself. This sorbite (which is practically Stead's sorbite) results from the decomposition *in situ* of martensite. An explanatory diagram is added. [See Abs. 1379 (1917).]

122. *Formation of Structurally Free Cementite in Soft Steel.* **Babochine.** (Russ. Metall. Soc., J. 1. pp. 561–571, 1915. Rev. de Mét. pp. 81–83, March–April, 1917.)—Small samples of a steel containing 0·17 0·026 % Si, 0·069 % S, 0·059 % P and 0·39 % Mn have been subjected to various thermal treatments, decarbonisation being prevented by covering with a of 2 parts KCl and 1 part $BaCl_2$, which mixture melts at 650° C. No annealing gives no structurally free cementite, but by very slow cooling through the $Ar1$ range (⅛ deg. C. per min. from 640° to 675° C.) structurally cementite is obtained in considerable quantities. Slow heating from 677 695° C. does not diminish the amount of structurally free cementite formed. The structurally free cementite can only be dissipated by maintaining the specimen at temperatures in the neighbourhood of 800° C. for at least followed by air cooling. Other tests indicate that Mn hinders the formation of structurally free cementite if present in excess of 0·6 %. In 0·2 % carbon steels, structurally free cementite forms readily if the rate of cooling in the region of the $Ar1$ point is less than 1 deg. per min. It appears, therefore, that under the technical conditions of rolling, forging, etc., the formation of structurally free cementite is inevitable. This leads to the conclusion that the lower the C and Mn contents of a steel and the slower its rate of cooling, the more fragile it becomes—somewhat paradoxical in the light of general experience which shows that the higher the C and Mn contents of a steel and the quicker it is cooled, the more fragile it becomes. F. C. A. H.

123. *Causes of the Streaky Structure of Iron.* **P. Oberhoffer** and **Hartmann.** (Stahl u. Eisen, 34. pp. 1245–1246, July 23, 1914. Rev. de M. 14E. pp. 199–201, Sept.–Oct., 1917.)—The streaky structure may be due to the presence of both slag enclosures and of phosphorus, the latter especially because high phosphorus and low carbon content go together. Experiments are being made to investigate the influence of these two factors, acting separately or together. An electrolytic iron (0·28 % C, 0·11 Mn, 0·006 S) was fused in an electric furnace (specimen 1); slag was added to this iron so as to obtain a metal (2) with 0·39 % C, 1·07 Mn, 0·178 S and a trace of P; metal (3) was made of high phosphorus content (0·14 C, 0·82 Mn, 0·011 S, 0·59 P). Metal 1 was quite homogeneous in structure; metals 2 and 3 turned very streaky after forging, and the structure was not caused by the irregular repartition of the carbon in the primary mixed crystals. The quantitative relations of the two causes are being studied. H. E.

124. *Further Observations on the Streaky Structure of Iron.* **P. Oberhoffer** and **H. Meyer.** (Stahl u. Eisen, 34. pp. 1241–1245, July 23, 1914. Rev. de

Mét. 14E. pp. 201–203, Sept.–Oct., 1917. Abstract.)—Further experiments (Oberhoffer, Stahl u. Eisen, 33. pp. 1569–1573, 1913. Zeits. Anorg. Chem. 81. pp. 156–169, 1913) on the *Zeilen* (streaky) structure which all forgeable irons assume when rolled or forged after having been heated above the A3 point [see preceding Abs.]. This structure is generally ascribed to the slag enclosures, which, being plastic, adapt themselves to deformation and afterwards serve as crystallisation nuclei for the ferrite. If that were so, an iron with much slag should show the lines more pronouncedly than an iron with little slag. The experiments confirm this view; but several factors have to be considered. A steel with 0·11 % C, 0·6 Mn, 0·4 Si, 0·03 P, 0·035 S containing little slag hardly showed the striæ after being forged down, heated to 950° and slowly cooled; another steel (0·13 C, 0·96 Mn, 0·06 Si, 0·072 P, 0·067 S), rich in slag, showed the striæ much more; reheating to 875°, at which the ferrite formation commences, followed by rapid cooling, in both cases suppressed the striation to a certain extent. The paper, which is illustrated by many photomicrographs, deals on the one hand with the production of the striæ, on the other with their cure by some thermal treatment. The second steel being also rich in phosphorus, which is known to concentrate near slag enclosures and blow-holes, the streaky structure might also be due to the phosphorus. But the P-streaks, which etching with ammoniacal cupric chloride renders visible, cannot be suppressed by thermal treatment because the diffusion power of P is low; those streaks persisted even after heating to 1450° and quenching. The streaky structure also impairs the mechanical properties, the strength and, especially, the elongation and contraction of area being much smaller when the fracture is parallel to the striæ than when at right angles to them; the etching of such a fracture would not disclose the real nature of the defect. There is for each steel a favourable thermal treatment, the conditions of which have to be studied. A nickel steel (0·14 C, 0·68 Mn, 4·75 Ni) did not show any striæ as prepared; the striæ appeared at 680°; by 710° the structure had become of much finer grain, and the striæ had almost vanished; at 740° they were as marked again as at 680°; at 780° the grain was much coarser and distinctly streaky. Further particulars concerning the most favourable temperatures are, it is stated, soon to be published by H. Meyer. The real cause of the heterogeneity of the structure is not the thermal treatment, which only determines the particular form of the striæ and their cure, but the hot work. Rapid cooling masks the heterogeneity, which reappears on reheating. On cooling, each fall of temperature is accompanied by the segregation of a certain quantity of ferrite, according to the equilibrium diagram. The greatest homogeneity will result when there are many ferrite grains, as small and as uniformly distributed as possible, counteracting the tendency of the slag enclosures to assume a streaky structure. This favourable condition is likely to be fulfilled in high-carbon steels and in nickel steels. Practically, rapid quenching is most essential for suppressing the streaks. References are made to the English literature on the subject. H. B.

125. *Variations in the Volume of Metals during Quenching.* **M. Oknoff.** (Russ. Metall. Soc., J. 1. pp. 442–455, 1915. Rev. de Mét. 14E. pp. 85–90, March–April, 1917.)—The researches of numerous investigators have shown that the A1 transformation in steels is accompanied by considerable variations in volume. Such variations occurring in a solid material whose particles possess only slight mobility must give rise to internal stresses either positive or negative. Pressure in a liquid is transmitted uniformly in all directions,

but in a solid there will be definite directions in which the stresses are at a maximum. It is conceivable therefore that the directions of the prepo derating stresses may cause a certain amount of regularity in the orientatio of the ferrite and cementite at the moment of their separation. If this is tru for pearlite then a lamellar structure should result in every case in which th decomposition of a solid solution is accompanied by a change in volum Experiments carried out on the eutectoids of the Cu-Al, Cu-Sn, and Cu-Z systems show that with the exception of the $\varepsilon + \gamma$ eutectoid of the Cu-Al serie all of them undergo considerable volume changes when the solid solution spl up. Microscopic examination shows that all the eutectoids possess lamel structures, with the exception of the $\varepsilon + \gamma$ eutectoid in the Cu-Al series; th gives a granular structure. It appears, therefore, that the condition necessar for the formation of a lamellar eutectoid is that a considerable volume-chang must take place during its formation. Obviously this is not the sole conditio a further one being that the constituents must have a certain degree of pla ticity during their formation. All the eutectoids examined except the o mentioned, showed a martensitic structure after quenching from above t transformation-point. The martensitic structure of quenched alloys is ther fore a function of the volume-changes. In the opinion of the author th confirms le Chatelier's theory of the mechanical nature of the hardening steel brought about by the operation of quenching. F. C. A. H.; I.

126. *The Forms in which Cementite appears in Hypereutectic Steel according t the Heat Treatment.* **N. G. Ilyine.** (Russ. Metall. Soc. J. 1. pp. 488–49 1915. Rev. de Mét. 14E. pp. 83–85, March–April, 1917.)—The forms of th cementite obtained in a steel containing 1·27 % C, 0·28 % Mn, 0·21 % S 0·035 % P, and 0·020 % S, have been studied as functions of (1) the tempera ture of heating, (2) rate of cooling, and (3) the duration of heating at a pre determined temperature. The results are as follows :—(1) The dimensions o the cementite network increase as the temperature of heating is increased (2) The rate of cooling has no influence on the dimensions of the cementit network. As the rate of cooling is slowed down, fewer cementite needles ar found in the pearlite grains. (3) Prolonged heating in the neighbourhood o 700° C. promotes the separation of granular cementite, which separation i favoured by a previous heating to higher temperatures. At temperature above 900° C. complete dissolution of the cementite is obtained if the heatin be sufficiently prolonged. For shorter periods (up to 2 hrs.) a thin networ of acicular cementite is obtained, according to the rate of cooling. Otherwis the effect of prolonging the period of heating is to increase the grain-size.

F. C. A. H. L

127. *Contact Catalysis.* I. **W. D. Bancroft.** (J. Phys. Chem. 21 pp. 573–602, Oct., 1917.)—The author gives a general summary and dis cussion of contact catalysis, and draws therefrom the following conclusions —(1) Only those substances which are adsorbed by a solid are catalysed by it. (2) While the catalytic action of solids may be solely the result of the increased surface concentration in some cases, this is not always the only factor. (3) A solid catalytic agent may be considered as equivalent to a solvent, and may therefore displace the equilibrium. (4) As a result of selec tive adsorption we may get different reaction products with different catalytic agents. (5) A catalytic agent tends to produce the system which it absorbs the most strongly.

A. F.